This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at http://books.google.com/

HARVARD UNIVERSITY
SEP 24 1947
GRADUATE SCHOOL
OF PUBLIC ADMINISTRATION

Harvard University
Library of the
Engineering School

GIFT OF
MARY RAYNER WHIPPLE
IN MEMORY OF
GEORGE CHANDLER WHIPPLE
Gordon McKay Professor
of Sanitary Engineering
1911–1924

HENRY WILLIAM VOGEL, PRESIDENT

1911

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK

PROCEEDINGS

FOR

1911

Edited by
GEORGE A. TABER, Chairman
PUBLICATION AND LIBRARY COMMITTEE

Published by The Municipal Engineers
Engineering Societies Building
29 West Thirty-ninth Street
New York

SEP 2
GRADUATE SCHOOL
OF PUBLIC ADMINISTRATION

Copyrighted 1912 by
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK

Note.—This Society is not responsible as a body, for the facts and opinions advanced in any of its publications.

CONTENTS.

PROCEEDINGS OF THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 62.

PRESENTED FEBRUARY 21ST, 1911.

THE GEOLOGY OF NEW YORK CITY AND ITS RELATIONS TO ENGINEERING PROBLEMS.

BY CHARLES P. BERKEY,* M. M. E. N. Y., AND
JOHN R. HEALY,† M. M. E. N. Y.

WITH DISCUSSION BY
THOMAS C. ATWOOD, ALFRED D. FLINN, AND CHARLES P. BERKEY.

PART I.—GENERAL GEOLOGY.

GEOGRAPHY.

New York City is built in large part on islands. Its so-called rivers are only the flooded channels between them or inlets and arms of the sea. Not one is a normal river, either in origin or behavior. In each the current sets first one way and then the other under tidal influence, which is so strong that even the Hudson yields to its control and the effects are noticeable on its waters inland for a hundred and fifty miles. These facts alone suggest to the geologist a complicated piece of history in late geologic time. In short, it means that the coast is drowned—*i. e.*, that the sea encroaches on the continental border farther than it did when the original channels were first made. The geographer must picture to himself the original condition before the outer coast sank beneath the sea. This much is necessary even to understand the geography of the region hereabout.

* Professor of Geology, Columbia University.
† Assistant Engineer, Board of Water Supply.

THE ROCK FLOOR.

The geologist must take still other steps back into the past. If one has made only the most casual observations it is readily appreciated that almost everywhere the surface is formed by loose material that we may for convenience call the soil. While in some places solid rock does come to the surface, these spots are never large in area. Only a little additional observation shows that at many places, covered wholly by soil, solid rock is to be found at a little depth. Thousands of such exposures are well known, and many hundreds of exploratory borings have proven the same relation in some places at still greater depth. Wherever a reasonable persistence in exploration is shown the loose soil material is found to lie on a bed rock that is not at all like it, and no more real soil is thereafter to be found, no matter how deep the exploration is carried. But this loose mantle is extremely variable in thickness. In occasional spots there is none, at many others there is as much as 200 ft. This leads the geologist to attempt, as best he may, to determine how the thick and thin portions are distributed, the reasons for such distribution, and to reconstruct the rock floor topography as it would look if all of the soil mantle could be scraped off. When this is done, it is evident that all of these islands, as well as the mainland, must present a form or outline that in some cases bears little resemblance to what we now see. Manhattan would appear as five or six separate islands, with a total area of less than two-thirds its present size. The whole southern portion below Eighth Street would cease to be. Its place would be usurped by the waters of the Upper Bay. Above Central Park almost the whole of Harlem would be submerged, except a small rocky island at Mount Morris Park and another rocky ridge extending along Seventh Avenue from One Hundred and Thirty-fifth Street northward to the present Harlem River. The rest would become a part of Long Island Sound and would be connected across to the Hudson along Manhattan Street with a channel in some places 150 ft. deep. On the north side, another island would extend from One Hundred and Twenty-sixth Street to Inwood above Fort George, where a second connection between the Hudson and the Harlem would mark its limits. The last one of these islands extends from Inwood to Spuyten Duyvil. Some of our

smaller islands would disappear entirely, and the western end of Long Island would be so changed that the present site of Brooklyn would lie largely under water. All of this the geologist tries to see and to understand. He appreciates the great differences of relief and the great irregularity of contour, but he has been taught to believe that there are good and sufficient reasons for each one of the features and occurrences—all of which it might be greatly to somebody's advantage to determine. The first step in such a process is to secure enough facts to establish a few principles of development and origin.

THE DRIFT.

For such purposes no set of facts is of so great importance as the composition and character and structure both of the soil mantle and of bed rock. It is readily established that on Manhattan the soil as a rule is very unlike the bed rock. It contains immense quantities of rock matter, sands and gravels and boulders, that could not under any circumstances be derived from bed rock where the soil now lies. Furthermore, it contains large boulders, generally mixed promiscuously through the mass, and seems to be almost as unlike the rock floor in depth as at the surface. This is regarded by the geologist as conclusive proof that the soil is of foreign derivation largely and that it has been spread unevenly over the rock floor by some agency not at present in evidence. Such a condition of affairs is, on the whole, abnormal. Soils are regularly developed by the disintegration and decay of bed rock *in situ*—they are the so-called residuary soils. The New York City soils are transported instead, and transported, furthermore, by a rather abnormal agency—one that could carry boulders and cobbles as well as sand and clay at the same time and to the same place. Such an agency might be expected to leave the deposits unevenly and somewhat promiscuously distributed. In other words, the present topography of the soil surface is not necessarily a duplicate of the topography of the rock floor, although the larger features of relief marked by the chief ridges and longer valleys may coincide.

It may be worth while to consider briefly the possible origin and source of such material. The experience of students of such questions shows that soils may be of very different origins. Some are simply decay of bed rock *in situ*, and this is one of the principal

types; some are alluvial—*i. e.,* river silt or lake deposits, largely confined to valley bottoms and great river valleys; some are wind-blown matters, dust and sand; and some are of glacial origin. These are the chief types. Both the wind-blown and the alluvial types are prevailingly fine-grained—seldom including anything coarser than fine gravel, and mostly made up of dust, silt, and fine sand. But the soil formed in place, residuary soil, and also the glacial soil, may have much coarser matters and sometimes may be very stony. To one or the other of these types all of the local mantle rock or soil belongs. Both occur, and it is often of some importance to be able to determine which, or, if both, at what point the change takes place.

Residuary soils are derived directly from the bed rock of the place, and are likely to preserve some of the rock structure where it has been least disturbed. The change is brought about by weathering. The rock is disintegrated, decayed, oxidized, attacked by the solvent action of rain water, and modified by plant life. Such rock fragments as there are resemble bed rock, modified only by this weathering attack. They are inclined to be angular or irregular in form and to be much more abundant in depth. The smaller and most modified fragments form its surface soil, while the larger and less modified fragments increase as solid bed rock is approached. The soil is well oxidized and shows gradual transition to bed rock. The soil mantle follows the rock contour consistently, having a little greater thickness in the valleys than on the hills or slopes.

Glacial soils or deposits, on the other hand, are of much greater variety. They contain much rounded material, especially the boulders and pebbles, and these are promiscuously distributed, the largest being quite as likely to lie on top as at the bottom. The pebbles represent many varieties of rock, most of which are more or less unlike the local types and may usually be identified with those of adjacent districts. Those most unlike are as often found immediately in contact with the bed rock itself as in any other position. The soil mantle is not much more modified at the surface than at depth, and the change to bed rock is abrupt. The rock floor is likely to exhibit a smoothed or grooved or striated surface and be sound and fresh. If the materials are pretty fine-grained, they are likely to be roughly stratified and show the effects of water assorting.

These are the criteria of residuary and glacial soils. It is certain that by far the greater portion of such material in New York City is of glacial origin, and that its source is from the region to the northward and northwestward, because the striations on the rock floor point that way, and because the boulders are readily identified with ledges of the Palisades of the Hudson, the Triassic brownstone of New Jersey, the gabbros of the Cortlandt series, the gneisses and schists of the Highlands, the slates and sandstones and quartzites and limestones of the Hudson Valley far to the north. More rarely perhaps even Adirondack and Catskill rocks are found.

All of this matter was dropped here by the melting of the ice, and it is usually called the glacial drift or simply the drift. There has been a tendency everywhere to fill old channels and pile the extra material about in an irregular manner. Many minor irregularities are thereby wholly obscured, but in most cases the larger original surface features still persist.

In most cases the presence of a loose mantle of this type increases the difficutly of the geologist because of the lack of conformity between the topography of the soil surface and that of the rock floor, and because where the rock floor is buried there is no direct evidence as to its character to be seen in the fragments of the soil.

BED ROCK.

It is evident, then, that bed rock has to be made a special and independent study. Since the glacial drift may be expected to have obliterated much of its earlier relief, some adequate method of reconstructing those former surface conditions must be found. Principles have to be formulated that will allow one to tell where the valleys ought to be and where the ridges ought to be, whether they look so now or not. This cannot even be guessed at unless first the exact distribution of the different rock formations and their structural relations, together with their relative behavior under weathering and erosion, are made out. In determining these factors, some of the most careful work has to be done. Observations are scattering at very best. Wide stretches, heavily covered, furnish no direct evidence at all, and sometimes old records and early observations are misleading or not properly understood.

In Greater New York, including both banks of the Hudson, there

are no less than eight distinct bed-rock formations whose characters and relations need to be understood. In addition there are several facies or variations in some of these formations themselves. Two of these distinct formations are confined to Long and Staten Islands. Three others are almost wholly confined to the west side of the Hudson, and the others are especially characteristic of Manhattan and the Bronx, although not wholly confined to these parts.

Tertiary Clays and Cretaceous Sands and Shales.

The two special formational units confined to Long and Staten Islands are each a series of sands and clays and shales—old sea deposits—lying upon the older crystalline rocks and gently dipping southeastward toward the sea. They need little special attention here. They are essentially an alternating series of pervious and impervious strata, and become important water-carriers along the southern margin of Long Island. They are the latest and the simplest of all of the local formations. They may best be referred to as the Tertiary Clays, and the Cretaceous Sands and Shales. They represent the simple sediments of the Atlantic Coastal plain, to which Long Island and a part of Staten Island belong.

These formations might be entirely removed and we should still have beneath them an older rock floor differing not at all from those portions yet to be described. They formed the rock floor before the Cretaceous and Tertiary strata were yet made, and it is largely from the weathering and erosion of these older strata farther inland that the material came which forms these later beds.

Triassic Sandstones and Palisade Trap.

The west side of the Hudson River has a really wonderful development of sandstones and shales, several thousand feet in total thickness, covering a large area in New Jersey. These beds dip gently westward. They are strongly bedded and usually brown in color and very quartzose, while the coarsest portions also contain an abundance of orthoclase feldspar. The coarser beds are moderately water-bearing, while the finer, more clayey layers are too close-textured for much circulation. They are simple and for the most part are not much changed from their original condition, except in the development of a better binding of the grains together, and

such baking and hardening as was done at the time of the Palisade Trap intrusion. Some of the finer shales were thus transformed into a hornstone of almost flinty character.

The Palisade Trap is an igneous rock in the form of a great layer or sheet or sill lying in the midst of the sandstone and shale beds. It was thrust between these beds as a molten, viscous mass, and the forces which encouraged it, with the help of the buoyant tendency of the magma, were at the same time able to lift the layers and force the thick viscous mass between. This sheet is 700 or 800 ft. thick in some places, and because of its superior hardness usually stands as a cliff which forms the most characteristic physical feature of the Lower Hudson. The rock itself is black, crystalline, hard, tough, and durable. It is essentially an aggregate of basic plagioclase feldspar, augite pyroxene, more or less olivine, and magnetite. The texture is that of a typical diabase and this is its proper petrographic classification.

The trap sheet is of course somewhat younger than the sandstone and shale beds between which it has been thrust, but there is fairly good outside evidence that it was formed in the same general period of geologic time, and it therefore very properly forms an integral part of the Triassic series. It must, of course, have a deeper connection somewhere, and it must have broken through whatever lies below, but these connections are now hidden from observation.

The whole Triassic series (known usually as the "Newark series") is older than the Cretaceous and always underlies these strata. But even the Triassic rocks lie upon a still older floor that was in existence before they were made. This older series which forms the more ancient floor not only lies beneath the Traissic series but occupies areas where all of these later strata have been removed by erosion, and at such places these rocks can be seen. These older rocks form the bed rock of Manhattan and the Bronx because there the later and overlying strata have been removed by erosion.

The Crystalline Metamorphic Rocks.

This older cyrstalline metamorphic rock floor is so much more important than any of the others just described that in most dis-

cussions no other is taken into account. Upon it all other formations lie. What is beneath it no one knows. Nothing older has yet been found in southeastern New York. All of its formations are ancient rocks themselves, but they were once made like others and must then have been as simple and as little modified as those already mentioned. They must have been laid down themselves on some still older floor which has not been uncovered. They were intruded by igneous masses in a somewhat similar manner to the Palisades, but by rock types of greater variety. In some places these original igneous types are so abundant as to make up almost the whole of the formations, while at other points in the same formation there are only thin stringers or dikes. For the most part, the older rock floor formations are essentially sediments that have been at some time very deeply buried beneath other later formations and in that position were subjected to folding and mountain forming movements, which finally so profoundly modified all of them that they now appear as completely recrystallized and foliated metamorphics in which all simple sedimentary characters are lost.

Enough evidence is still available from their composition and structures and relations to each other to show that they were originally sedimentary rocks—old limestones, sandstones, shales, and muds. All of the igneous members are younger and cut the original formations in the manner of intrusions. Because of original variation, and subsequent further modification by metamorphism and still further complication by igneous action, all of these rocks are complex and exhibit great variety and sometimes extremely unlike facies in the same formation. This adds immensely to the difficulty of identification and proper interpretation. Sometimes the rather abnormal facies of two different formations look practically alike, and then additional data must be secured. But it always is possible with a fairly representative suite of specimens to identify accurately all of these rocks.

This ancient rock floor is made up chiefly of three very important formations, which together occupy great areas far beyond the boundaries of New York City. These are known locally as *Manhattan Schist, Inwood Limestone* and *Fordham Gneiss.* Besides these there are in New York City three important ancient intrusives of sufficient size and practical importance to warrant separate

description, although they have not the same rank as the three first mentioned. One, probably the youngest of them, is known locally as the *Staten Island or the Hoboken Serpentine,* found in at least three separated localities, the largest of which forms the elevated portion of Staten Island and the Knob at Castle Point in Hoboken. In all cases probably it is more closely associated with the Manhattan Schist than with any other of the important formations.

Another is now known to be of large areal extent in Long Island City and Brooklyn, extending beneath the East River into the Lower East Side on Manhattan. It is known to the recent workers in the geology of New York City as the *Ravenswood Granodiorite.* It is probably the most ancient igneous or strictly intrusive rock in New York City and is associated only with the Fordham Gneiss, the oldest of all the formations in southeastern New York.

The other prominent intrusive occurs only in the northern portion of the City, near the Yonkers line, and really appears as a large wedge extending southward directly toward Jerome Park Reservoir. The rock is a biotite granite in composition, but has a gneissic (slightly foliated) structure due to original habit or to metamorphic influence. It belongs to the Fordham Gneiss series, very much like the Ravenswood Granodiorite, and probably does not differ very much from it in age. This member of the formation is well known as the *Yonkers Gneiss.*

Manhattan Schist.—The most extensively developed of the three important crystalline formations is the Manhattan Schist. It covers easily two-thirds of Manhattan Island and very large areas in the Bronx. It is almost the only rock exposed in outcrops and street cuttings in the ordinary engineering work on Manhattan. It is given various names in the older records and publications. A common one in certain engineering bureaus is Gneiss or Schist or Granite or Mica rock or simply the Manhattan bed rock. In the U. S. Geological folio of New York City, No. 83, the same rock is called Hudson Schist, a name adopted because of a supposed correlation making it the crystalline equivalent of the Hudson River shales, a very extensive and important formation in the Hudson Valley north of the Highlands. The senior author of this paper has shown elsewhere that such correlation has still many unsatisfied points, and considers it better usage for all practical pur-

poses in City work to preserve the original local name—Manhattan Schist.

This rock is primarily a re-crystallized sediment. The fact that it does not show any sedimentary or fragmental character now is due wholly to its profound metamorphism. It presents considerable variety of texture and composition, probably reflecting original differences in the quality of the sediments, which were doubtless simple silicious muds and silts. In its present modified condition it is a grayish, or nearly black, or irregularly streaked micaceous, coarse to medium grained, strongly foliated rock. The most prominent constituents are the micas, both muscovite and biotite, and quartz. In most cases biotite is abundant enough to give a very dark color to the rock, but in spite of this fact the most characteristic mineral of all is a pearly white mica, a variety of muscovite. The rock gets its strongly foliated character from these two minerals, which in most all instances have developed a coarse flaky structure, and it is this fact which makes the rock look coarse grained. To a lesser extent feldspar and garnet and hornblende and epidote and fibrolite occur. Their abundance varies greatly in different parts of the formation. Some of the quartz is doubtless original, that is, it represents some of the actual grains of the sediment, but probably the greater portion of it and practically all of the other enumerated constituents in the average specimen of schist, are secondary derivatives from the processes of metamorphism. The original clays and other constituents of the old sediment have been worked over and caused to combine into more complicated compounds of higher specific gravity and greater compactness of form, a process that has resulted in producing the group of mineral constituents just described. Occasional streaks or masses or lenses of a very black rock, consisting essentially of hornblende and a little feldspar or quartz, occur in the formation. They are always distinguished from the standard micaceous variety and their boundaries are reasonably sharp. Their occurrence and composition lead to the opinion that they are metamorphosed ancient dikes and similar intrusions of a rock very like a trap or diabase, and that subsequent metamorphic modifications have changed it to a typical hornblende schist.

Metamorphic rocks of these characters are classified on the basis of their structure and texture, and their chief mineral makeup is as follows:

Foliated Metamorphic Rocks.

(*a*) Coarse to medium grain and normal (feldspar) composition = *The Gneisses.*

(*b*) Coarse to medium and fine grain and abnormal composition = *The Schists.*

(*c*) Fine grain and micaceous composition = *The Phyllites.*

(*d*) Very fine grain and silicious or meta-argillaceous composition = *The Slates.*

These are the great groups of foliated metamorphic rocks. In separating them there is, as is usual in all classifications, little difficulty with typical cases, but much difficulty with intermediate ones. Only two terms used above need further explanation. These are the words *normal* and *abnormal* used in describing the differences of composition between the gneisses and the schists. By the term normal is meant a mineral aggregate somewhat similar to that found in standard igneous rocks. In such rocks feldspar is always a very prominent constituent, therefore the term normal as here used means rather strongly feldspathic. The term abnormal, of course, is used in contrast. It is meant to cover rocks in which feldspar is too low to be counted a leading constituent and rocks which have compositions which as a whole are quite unlike standard igneous types.

It is clear, therefore, in view of the foliated structure and the generally abnormal composition and medium texture, that the Manhattan formation rocks are in most cases typical schists.

The schists as a group are subdivided on the basis of that mineral constituent to which their foliation is chiefly due, or which is of greatest abundance in their composition. Thus schists are known as mica schists, hornblende schists, epidote schists, etc.,—a rather long list.

It is clear here again that the Manhattan formation rocks, as an average, are essentially mica schists or quartz-mica schists, while smaller portions of the formation here and there fall into other varieties, such as hornblende schist, epidote schist, fibrolite schist, and perhaps still others. The formation, as a whole, is a mica schist. But in many places it is rather exceptionally coarse grained. Its abnormal composition is then the best defense for the classification

as a schist. When garnet is strongly developed it is simply called a garnetiferous mica schist.

The abundance of mica makes it a tough rock, but not very hard. On the whole, the rock is fresh and not susceptible to rapid decay or easy disintegration. The formational foliation or structure varies slightly, but on the average has a north 30° east trend, a course that is also preserved in the general relief of the rock floor.

The formation is in places much impregnated or cut into by granite-like lenses and stringers and masses and dikes. These are locally known as Pegmatites. It is their presence, doubtless, which has often led to many of the older references to this rock as a granite. These pegmatite occurrences modify the appearance of the rock very much. It becomes knotted or streaked or bunchy, and presents considerable diversity both of structure and composition. But they are essentially intrusive matters that have been introduced into it as igneous injections or have penetrated the rocks with solutions from some igneous source. They belong to a fairly late stage of the rock development.

The formation has great thickness, but because of the destruction of practically all original bedding lines by recrystallization and the additional complication caused by folding and shearing, its structure cannot be fully determined and the thickness can not be estimated with any approach to accuracy. But there is probably a thickness of several thousand feet.

The serpentines of this district are associated with the Manhattan formation. Several occurrences are known, the largest of which is on Staten Island. It is an old intrusive, a very basic igneous rock, a gabbros in general original composition, which has been changed by metamorphism to its present condition. Serpentinous secondary products are the most prominent constituents now and they give the green color to these rocks. Serpentines are usually treacherous rocks in engineering work. Some rare minerals occur in them and they are of much interest in a geologic way. In age they are clearly younger than the Manhattan schist, which they cut, but seem from their excessive metamorphism to be very old, and they date back nearly as far as the schists themselves.

Inwood Limestone.—The formation to which this name was given is exposed at many places in the Bronx, but has very few outcrops

on Manhattan. The type locality, however, is at Inwood in northern Manhattan, from which the name is derived. Other names used for it are Tuckahoe marble and Sing Sing marble and Stockbridge dolomite. The latter name is used in the geologic folio, No. 83, of New York City, because of a supposed correllation with the Stockbridge dolomite of Massachusetts. Whether or not this assumed equivalance of formation is correct no one is in position to say. In any case for local purposes the local name, Inwood limestone, or Inwood dolomite, which avoids any uncertainties of correlation, is preferable.

This rock is everywhere coarsely crystalline, either massive or strongly bedded, with abundant impurities in certain beds. These impurities are themselves crystallized from original silicious and clayey constituents deposited with the lime, but which now appear as a brown mica (phlogopite), a green chlorite, tremolite and quartz. As a whole, the rock is essentially a coarse marble. The composition is more strongly magnesian than usual and, therefore, it may be regarded very properly as a magnesian marble, or dolomite.

The coarser grades upon exposure to weathering disintegrate rather readily to an angular lime or calcite sand closely resembling an ordinary sand in general appearance. At Inwood, the type locality, this disintegration is so pronounced that great quantities are loose enough to be shoveled up and used for various structural purposes in the place of other sand. The formation lies conformable with Manhattan schist, and there is usually a transition from one formation to the other by a series of alternating thin beds of very calcareous schist and strongly micaceous limestone. A thickness of 750 ft. is fairly accurately known from the New Croton Aqueduct tunnel under the Harlem River, where the whole formation was penetrated, and from the borings on the proposed distribution conduit for the Catskill supply where this line also crosses the Harlem River. There are no fossils, and this formation, together with the Manhattan schist, are of undermined age. They are certainly not younger than the Ordivician and may be much older—even Precambrian.

On account of the tendency to disintegration under weathering influence, areas of Inwood limestone do not form prominent ridges

like the schist, but are much more likely to form the bed rock of the flats and valleys.

Fordham Gneiss.—The most complex formation of all is the Fordham gneiss which lies at the base of the whole series. It includes both metamorphosed ancient sediments and igneous intrusives, some of which are very extensive. The oldest member of this formation is made up of a series of banded black and white gneisses, black mica schists, thin beds of very impure serpentinous limestone, quartzite schist, quartzose gneisses and graphitic schists, forming together a unit through which and into which the igneous masses have been injected. Its characteristics and relation lead to the belief that it is the local representative of the Grenville series of the Adirondacks and Canada and that it is of very old Precambrian age.

No single type and no single characteristic can be given as a guide to the identification of this formation. The prevalence of certain varieties, however, especially the strongly banded black and white gneiss, gives a certain degree of character that forms a reasonably reliable working base.

Average specimens of the Fordham gneiss carry abundant feldspar, and although mica is a common constituent it is almost always the black biotite variety. The white, pearly mica, so characteristic of the Manhattan schist is almost entirely lacking in the Fordham formation. By all means the most reliable differences between Manhattan and the Fordham formation are these:

(*a*) A more strongly and evenly banded structure of the Fordham.

(*b*) A greater content of feldspar as a mineral constituent of the Fordham.

(*c*) A greater prevalence of mica and especially of a white, pearly mica in the Manhattan.

(*d*) A greater diversity of rock character in adjacent beds in the Fordham.

Certain of the more rare varieties of Manhattan and Fordham are so similar that in small samples or small outcrops they cannot always be differentiated, but typical material is readily determined.

Gneisses are classified on the basis of their general mineral composition, as granite gneiss, where the composition is similar to that

of a granite; syenite gness, when the composition is that of a syenite; and similarly, diorite gneiss and gabbro gneiss. The basis is similar to that employed in grouping coarse-grained igneous rocks. Only the foliated texture of gneiss, which is a metamorphic effect, gives them a different appearance and meaning. Gneisses that are known to have been formed not directly from igneous types, but that are recrystallized older sediments, are sometimes referred to as granitic gneisses instead of granite gneiss, or syenitic and dioritic gneisses. The composition is still indicated in the name, but there is an attempt to avoid suggesting that the gneiss has been derived directly from an igneous original.

On this basis the Fordham formation is a fairly good series of gneisses. The most abundant constituents in almost all members are orthoclase and microcline feldspar, quartz, and biotite. These are the typical constituents of the granites. They always have a more or less foliated structure. Therefore, they are gneisses—either granite or granite gneisses, or both. As a matter of fact, no doubt there are both types, *i. e.*, gneisses from igneous originals as well as from the recrystallization of arkose sediments. In many cases it is believed to be impossible to tell what the original may have been. On the whole, the term granitic gneiss, used to avoid the question of original, is the preferable one.

Interbedded Limestone.—There are in the Fordham formation, of course, certain very limited members, mostly thin beds, which cannot be classed separately as gneisses at all. Some are crystalline limestones interbedded with the gneisses. Others are more strictly schists which so closely resemble the Manhattan that they cannot be distinguished in small single specimens alone.

Some of the most interesting of recent developments in the geological problems of the City have had to do with the interbedded limestones associated with the Fordham. They are undoubtedly as much a part of the formation as any other member. They furnish one of the best evidences of the sedimentary origin of a portion of the formation.

These limestones are best developed in the Bronx, in the vicinity of Jerome Park Reservoir, and on Manhattan on the Lower East Side, where recent explorations have also discovered this member beneath very heavy drift cover. Isolated specimens cannot be dis-

tinguished from the Inwood limestone, but the field relations prove that they are of entirely different age.

Ravenswood Granodiorite.—In addition to such variations there are many separate igneous intrusions, mostly of a granite character, or some close relative. These give still greater variety to the Fordham formation as a whole. The chief one of these covers a large area in the East River section, and is so uniform as to deserve a special designation in spite of the fact that it really forms an integral part of the complex Fordham series. This rock is slightly foliated, but not banded. It varies enough in composition to range from a true granite almost to a typical diorite. It is, therefore, called a granodiorite and since its type locality is at Ravenswood, the name *Ravenswood Granodiorite*, given to it some years ago by Professor James F. Kemp, is particularly appropriate. It is the most uniform and substantial rock of large area in New York City. It is of special importance on certain portions of the projected distribution conduit in its East River and Brooklyn sections.

Yonkers Gneiss.—Another important intrusive of granite character comes into the Fordham series near the Yonkers line and has a much more extensive development in Westchester County to the northward. This member is also foliated and is, therefore, a gneiss. It has the simplest and most uniform structure and composition of any local rock. It is reddish to light pink in color, usually of medium grain and not banded. It is a younger rock than the banded and more complicated members of the Fordham—probably not very different from the Ravenswood granodiorite in origin, age and history.

Because of the great complexity of the Fordham and the association with it of members that are very unlike the fundamental type in origin and composition and general appearance, the term preferred for the whole formation is Fordham Gneiss Series. In a treatment of the general geology of the region, or in a broad conception of the chief units of geologic structure and history, the Fordham Series must be regarded as a unit. It is the oldest and most modified and most complex and most extensive of them all. It is the base of the geologic column for southeastern New York.

Pegmatites.—Veins, stringers, dikes, and lenses or bunches of coarsely crystalline feldspar and quartz and mica occur in all of the

crystalline formations. These are the so-called *pegmatites.* They are extremely abundant in the Fordham and Manhattan formations. They are probably largely of igneous origin, but in many cases do not seem to be direct solidifications from fusion, but more nearly like vein precipitation from circulating solutions or like segregations. These pegmatites never attain the importance of the other members ranked above as separate formations, but their abundance in certain portions of the Manhattan schist and Fordham gneiss profoundly modifies its appearance and character.

STRUCTURAL FEATURES.

All but the old crystalline rocks have a very simple structural relation. The younger ones, the Tertiary and Cretaceous strata, lie with gentle uniform dip toward the sea, and the successive beds lie one above the other in very regular order. Individual beds thicken and thin out in accord with their conditions of original deposition, but they are not modified to a noticeable amount by strictly secondary forces.

The intermediate ones, the Triassic (Newark) sandstones and shales, have also a simple relation and structure. They dip gently westward with a dip of somewhat over 15 degrees. They are, however, more modified than the Cretaceous above. They are tilted more, they are faulted a little, and they are affected by simple sheet intrusion of the Palisade trap.

Folds of the Older Series.

The ancient rock floor formations are immensely more complicated in their relation and structure. Everywhere the Manhattan schist and Inwood limestone and Fordham gneiss occur in strips lying more or less persistently parallel with each other. A strip of Inwood limestone a few hundred feet wide is usually bounded on one side by Fordham gneiss and on the other by Manhattan schist. This succession is repeated so often that there is no doubt whatever that it is the normal order. But also the formations almost everywhere indicate that they are highly tilted and often actually stand on edge. They were not originally deposited in this position, but have been subsequently forced into such position by lateral thrusts which crumpled the beds together into a series of

folds. Long continued erosion, ages ago, removed the most exposed portion, and only the stumps of the original folds remain. Therefore, each strip of limestone marks the limb of a fold as it comes to the surface, and the geologist pictures to himself the curve that it used to make, now an imaginary arch in the air coming down and passing below the surface again over beyond the adjacent ridge of gneiss. He tries then to imagine the beds as they extend down some hundreds or thousands of feet below the surface, until turning upward again on the other side of the trough they finally reach the surface as in the first case. The whole proceeding is neither obscure nor difficult, and it is an absolutely necessary step to take if one wishes a working understanding of the structural relations of these older formations. A little careful observation will then convince one that the formation found within the limestone arches is always Fordham gneiss, and that the formation found within the limestone troughs is always Manhattan schist. Such distribution and relation can have only one meaning, *i. e.*, the Fordham is the basal and oldest member, the Inwood lies above it, and the Manhattan is the upper member of the series. Wherever Manhattan schist is the surface formation one can find the Inwood limestone and Fordham gneiss below it if only the exploration be carried deep enough. On the other hand, no matter how deep the Fordham gneiss is penetrated no other formation has yet been found beneath. Folding so closely repeated, such as is exhibited in these rocks, is never perfectly symmetrical. In New York City sometimes the beds are tilted even beyond the vertical (overturned). If locally they seem to be very differently related, knowing the standard succession, there need be no difficulty at all in detecting the occurrence as abnormal. There are no flat-lying beds. Large areas of a single formation, such as of schist in the eastern portion of the Bronx or in western Manhattan, means that the crests of the underlying limestone and gneiss do not reach to the surface and consequently the whole surface is schist. But structurally the schist of those areas is folded into troughs and arches just as systematically as are the formations where the whole series is exposed. The series of folds has been formed by thrusts that seem to have acted from the southeast, and consequently the axes of the folds trend northeast and southwest. All of the belts or strips of these formations, therefore, also have

the same trend. Furthermore, the axes of the folds pitch slightly to the southwest.

Faults.

An additional source of complexity lies in the fracturing and displacement of two portions of a formation which originally lay immediately adjacent. This is known as faulting. When this occurs the regular succession may be abruptly changed. In some instances a whole formation is cut out, and two that normally do not belong together are brought into contact. Such an effect is brought about between Blackwell's Island and Manhattan, where a tunnel at Seventy-second Street shows that Manhattan schist lies in contact with Fordham gneiss. Most of the known faults have taken place along breaks that trend northeasterly with the structure, but others running northwesterly across the formational structure are also well known. Fault planes are places of weakness which, if not rehealed by deposition or recrystallization, become the principal courses of water circulation. This has a double bearing. It marks out the places where deeper decay than usual is to be found, and it also marks the chief sources of water supply for wells drilled into the crystalline rock.

Both folding and faulting have taken place in different geologic periods. In the case of faults, the older ones are more likely to be rehealed and to be about as impervious and durable as any other portion of the rock, while the latest ones are usually not healed and their broken or open character encourages circulation and consequent solution and decay effects.

The greatest of the local faults is probably that following the course of the Hudson River. The west side of the Hudson is apparently dropped down with respect to the east side. The position of the fault is such as to defy direct observation, but general regional relations favor its existence.

Unconformities.

There is a missing link here and there in the succession of formations. The first one is between the Fordham gneiss and the Inwood limestone, but their other complications overshadow this feature, so that its existence is not readily detected. Then between the Manhattan schist and the Triassic sandstones there is also a

very great unconformity. One of much less consequence lies above the Triassic, and another great one again between all of the bed rock formations and the drift. They all mark time breaks or missing pages in the geologic record. These structural features are shown graphically on the accompanying geologic cross-section, Plate 1.

GEOLOGIC HISTORY.

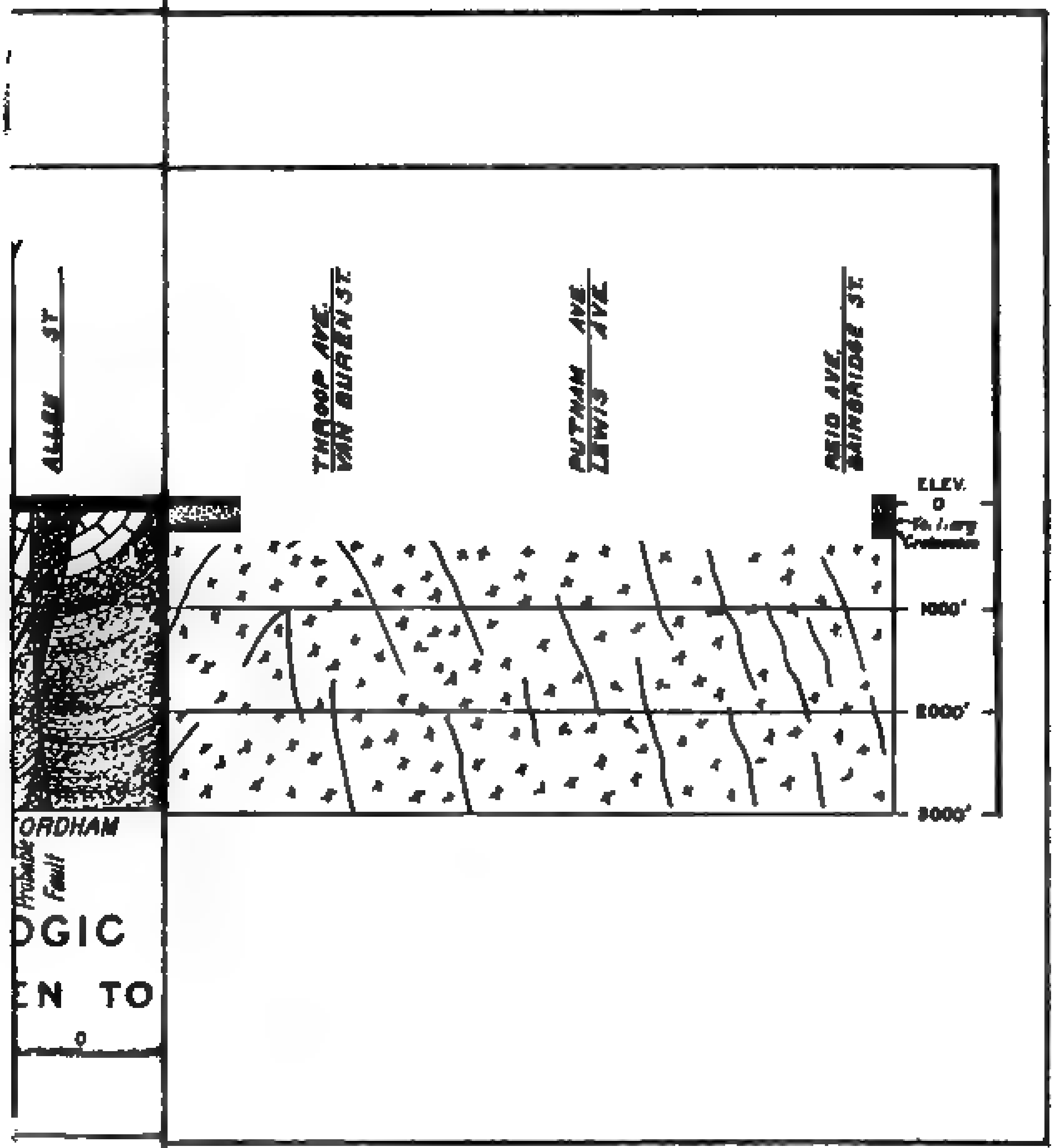
The succession of events based upon the features just described is comparatively easily determined, and is somewhat as follows:

In early Precambrian time a great series of sediments were being laid down consisting of sands, clays, arkoses and small beds of limestone, destined ultimately to form the basis of the Fordham gneiss. These were subsequently folded and injected with igneous intrusions of a complex sort, somewhat metamorphosed, and then subjected to extensive erosion. This erosion marks the time break of the earliest unconformity.

Subsequently the Fordham land surface was depressed below sea level and the Inwood limestone was deposited, followed above by an immense thickness of muds and sandy clays and other mixed sediments which were later to become the Manhattan schist. There may have been still other formations deposited which are now wholly removed. When the area was again raised above the sea these formations were affected by mountain-folding and were subjected to metamorphic processes which entirely recrystallized these old, deeply buried sediments and made them take on something of their present appearance and character. Erosion attacked the area and reduced it to a pretty uniform level. This erosion marks one of the largest unconformities. A very long interval is lost—maybe most of the long era of geologic time known as the Paleozoic era. The region passed in this interval through at least one more mountain-making epoch at the close of the Carboniferous age, when the Appalachian mountain folds were made. But there is no readable record in this area. Somewhere during this time there was extensive igneous activity, which seems to have manifested itself chiefly in numerous intrusions. To this interval belong the serpentines, the old trap dikes, the pegmatites, and perhaps local granites. This was the period of most profound metamorphism.

Still later the heavy and very thick Triassic strata were accumu-

PLATE 1.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
BERKEY AND HEALY ON THE GEOLOGY
OF NEW YORK CITY.



lated in basins or troughs along the bases of the ancient mountains out of the débris derived from their destruction. Later, with smaller missing intervals, the regular marine sedimentary beds were laid down one over another, including all the strata known in this locality.

This succession of formations and events may be tabulated as follows:

PRESENT EROSION CYCLE.

Glacial Drift.—Unconformity and lost interval, showing erosion.

Tertiary Clays.—Overlap and lost interval, with warping of the continental border.

Cretaceous Sands and Shales.—Disconformity or moderate unconformity, representing a lost interval with some igneous activity and small faulting.

Triassic Sandstones and Traps.—Great unconformity and lost interval, including two mountain-making epochs = the Green Mountains (Post-Ordovician) and the Appalachian (Post-Carboniferous) and with considerable igneous activity.

Manhattan Schist and Inwood Limestone.—Unconformity or overlap and lost interval, with much igneous activity appearing as intrusions.

Fordham Gneiss Series.—Earlier history unknown.

PHYSIOGRAPHY.

Present surface features are everywhere the result of the orderly work of a few well-known geologic agencies acting on the combination of formations that in the vicissitudes of past geologic time have been developed as the rock floor of a region. The agencies of most consequence are the atmosphere, surface heat, water and internal forces. The activities of most importance are atmospheric weathering, changes of temperature, wind action, the erosive action and transportation work of water, and shifting of levels caused by internal dynamic forces.

The agencies and their activities are very much the same in adjacent regions, especially the so-called surface agencies and processes, but in spite of that in most cases adjacent regions are very unlike in the character of their relief. Staten Island is strikingly different in the character of its relief from Long Island, and these

both are entirely different from Manhattan, while all three have almost nothing in common with areas lying across the Hudson in New Jersey. The Highlands of New York are exceedingly unlike the Catskills in almost every feature, except that both have mountainous elevations and both have streams and valleys. The different regions have back of them a different history which is preserved permanently in the condition and relations and structures of its rock floor formations, and, however long and peristently the agencies of erosion may work, the resulting relief will always be consistent with these factors. On the other hand, if one knew all of the niceties of relief character that could arise from every variety of rock and rock structure, it ought to be possible to work backwards and interpret underground conditions from the physiographic features of the surface alone. There is such close interdependence of relief feature and rock structure that the geologist constantly uses the principles thus established as one of his greatest aids in deciphering the areal and structural geology of a region where the fundamental units or formations are known.

For New York City and adjacent districts the starting point of the present surface form dates back to Cretaceous time. The continent stood then for an exceedingly long time only moderately elevated above sea level, and remained stable so long that nearly everything was worn down to a simple plain of erosion so very flat that it is always referred to as the "Cretaceous peneplain." On the divides between the greater stream courses of that time, of course, there were occasional areas that had not yet been worn down to the general level. These patches were either of harder rock type or so distant from the best channels of erosion that they lagged behind in the general reduction of surface. Such an area represented the present Catskill Mountains. But almost none of our present-day relief features about New York City were in existence, except potentially in the differences of structure of the rock floor of that time. That ancient plain existed somewhat above the level of the average elevation of the tops of our highest hills in southeastern New York. This Cretaceous peneplain drained into the Atlantic, where the waste that the streams carried accumulated as Cretaceous sands and shales. As a whole it must have reached present sea level at about the East River and the Upper Bay and must have

PLATE 2.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
BERKEY AND HEALY ON THE GEOLOGY
OF NEW YORK CITY.

LOCATION OF GEOLOGICAL SECTION SHOWN ON PLATE 1.

risen gradually inland for several hundred miles. The streams flowed sluggishly over silts and sands and heavy residuary soil which obscured the rock floor everywhere. The underlying rocks, therefore, had no control of the stream courses as they flowed on the alluvial deposits above.

But at the close of Cretaceous time the whole continental margin was elevated at least several hundred feet, perhaps inland as much as two thousand feet, above its former level and warped and tilted somewhat unevenly toward the sea. Then the work of erosion was actively renewed (rejuvenated).

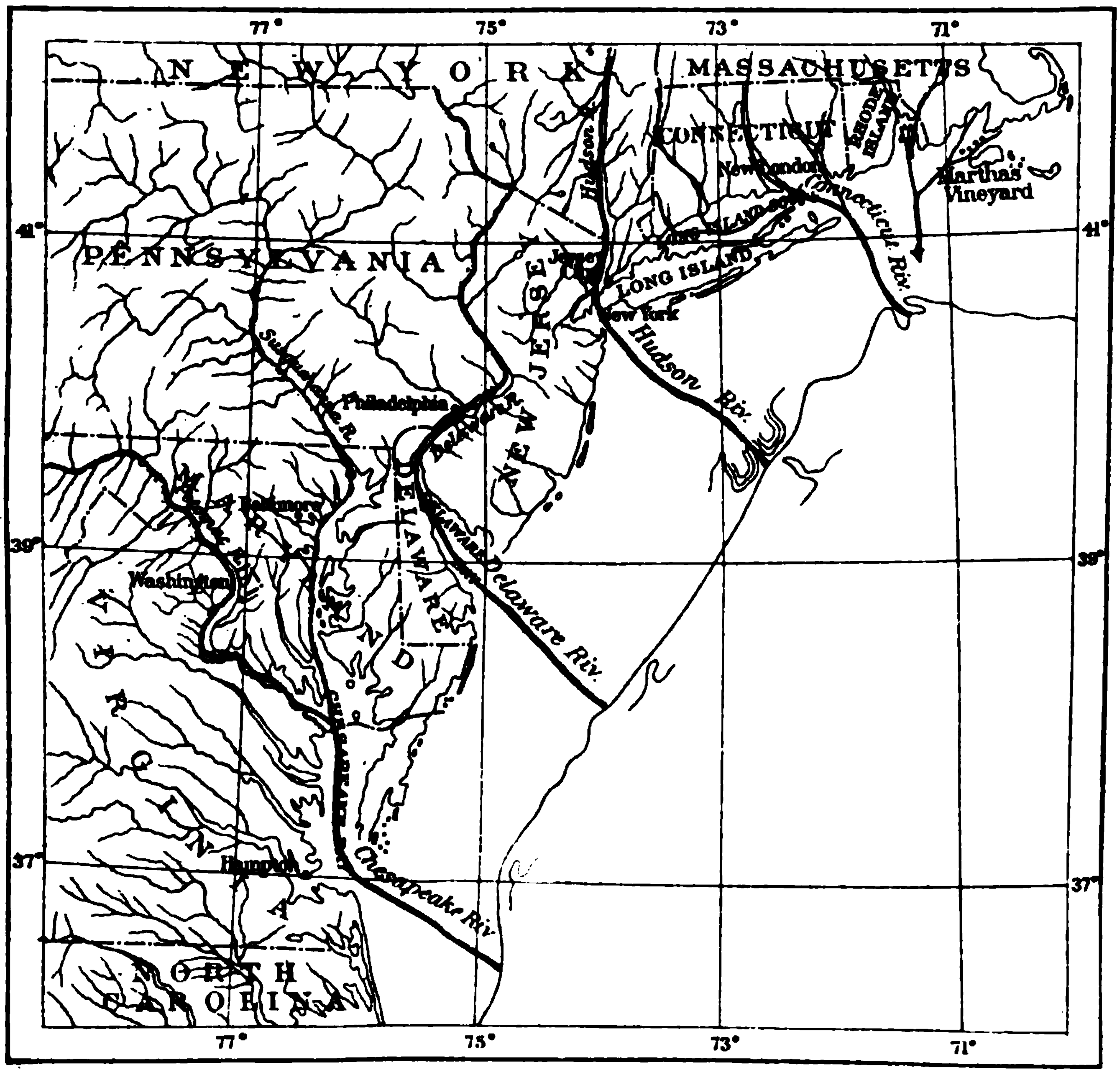
All of the relief that we now see has been carved out of that old plain by the erosive activity of the streams and other surface agencies since that time. Portions that now form the hilltops and mountain tops of this district and adjacent ones were in the beginning of this epoch constituent parts of the rock floor of the peneplain. As soon as streams had cut down through their alluvium to bed rock again and this obscuring mantle was removed, they began to lay out the lines on which present-day relief has been developed. The making of valleys may be considered the primary work of a stream. This is accomplished by removing the disintegrating rock and soil as it is formed on the rock floor. Where no such disintegration is taking place little work can be done; wherever decay is rapid there it is also possible for much work to be done by the stream, and by the removal of débris the beginnings of a valley are made. Thus it happens that streams have great facility in finding and following the softest or most easily attacked lines or zones or belts or formations—a fact that is of immense practical value to the geologist and engineer. Stream distribution is studied with great care. They furnish clews to weaknesses or other structures that are too obscure for any other agency to find. In the course of time, after the main streams and tributaries have had opportunity to discover the easiest lines, the structure of the rock floor of a region like New York is indicated by them almost as clearly as the lines of a geological map. This is what the physiographer calls adjusted drainage.

When the continent was elevated at the close of Cretaceous time and streams were rejuvenated and valley-making began anew, the streams that were already in existence on the old peneplain surface

soon removed the alluvium that covered the rock floor and discovered a rock structure inconsistent with the courses they then had. Some of the master streams were large enough to establish channels that kept them in their original courses, in spite of the fact that later they found themselves crossing hard and soft, very resistant and very easily destroyed formations. Such behavior is credited to the Hudson. But most of the tributary or smaller streams of all kinds shifted into the prevalent structural lines. The hard and soft beds, the trend of folds, the strike of strata, the position of fault zones, the areas of harder igneous or crystalline rock were discovered. Valleys were made where the softer ones are, ridges were left where the harder ones are, and surface relief took on the beginnings of present-day lines. Only the hills were not so high above the valleys, because the valleys were not yet cut so deep below the level of the old peneplain. As would be expected, the main ridges in the areas of the older crystalline rocks, including the Manhattan-Inwood-Fordham series, developed rounded outline and a trend northeast and southwest parallel to their structure. In the Triassic there came to be prevalent a series of eastward facing cliffs surmounted by the very uniform ridges that gradually die away to the westward in gentle dip slopes only to be succeeded by still others of similar form, a form that is accentuated wherever igneous intrusions occur. The Lower Hudson exhibits such character. In the Cretaceous and Tertiary the steeper sides face northward and the gentler slopes toward the sea. Long Island Sound Valley, which is now simply drowned, is one of this type. The Northern margin of Long Island constitutes a steeper northward facing slope while the gentle southern slope reaches to the sea.

If the continent were to stand stable for long enough time the whole region would once more be worn down to another and lower peneplain. The tendency would be for the large streams, which work rapidly, to cut down their valleys to approximately the final level first. Additional work then widens them into flat-bottomed valleys which, by further widening and extension, mark out the new peneplain position with considerable definiteness. The position of it below the original Cretaceous peneplain would depend upon the elevation of the continent above the sea. At least one such level was marked out in Tertiary time. The continent stood somewhat lower than

PLATE 3.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
BERKEY AND HEALY ON THE GEOLOGY
OF NEW YORK CITY.



Sketch Map of a Portion of the Atlantic Coast, Modified from Veatch, Intended to Show the Following Features:

(*a*) The coast line at a time of much greater continental elevation, such as that preceding the Glacial period, and perhaps during a part of that time.

(*b*) The approximate courses of the principal rivers crossing the Coastal Plain.

(*c*) The present coast line, which is but one of several different positions occupied in comparatively recent geologic time.

now. The streams reached grade and began developing wide flat-bottomed valleys marking out the new peneplain. But before it was a third finished a second elevation affected the region, the whole continental border was raised a few hundred feet and again warped or tilted seaward, the streams were rejuvenated and began to cut notches into the bottoms of their flat-bottomed valleys, making valleys within valleys everywhere.

These processes and principles are the key to an understanding of local surface features. The rock floor in New York is a surface developed in this way. It has a form perfectly consistent with such stages of history, such selective activity of erosion agents and such structural control. Its most perfect development had been reached in Pleistocene time, just preceding the Ice age.

But just before the glacial occupation the continent was again greatly elevated, the largest streams cut deep, narrow gorges, which were incomplete when the continental glacier began to cover it. The ice scraped off the exposed prominences, plowed up the residuary soil, carried in immense quantities of waste rock from more northerly areas, and finally withdrew leaving the mixed lot choking our valleys, obscuring our escarpments and covering most of our rock floor. It has done three things that modify the perfect stream erosion topography that had previously been developed. (*a*) It removed much loose soil, (*b*) it gouged out or broke off a good deal of more substantial rock, actually widening and deepening some of the gorges and valleys wherever their courses encouraged ice-flow, and (*c*) it has piled up glacial drift in such a promiscuous way that many of the finer relief lines are obscured.

Some of these drift deposits were carried from the ice during the thawing season and were assorted and laid down as roughly stratified sands and gravels or silts. Such material is very porous and usually heavily water-bearing. Other drift deposits are more dense mixtures of clay and sand and boulders, which are more nearly impervious. They are the so-called ground moraines. Their distribution is, of course, consistent with the conditions of their time also, but it is not advisable to take the question up more fully here. It often happens that character of drift in a given locality is the most important geologic factor in a problem.

Such, in general outline, is the origin of the features of New York City with which the practical geologist is concerned.

PART II.—APPLIED GEOLOGY.

The foregoing pages contain a systematic statement of the local geology. It has been our purpose to state geologic principles and describe the standard and characteristic local features in such terms that any one may understand them and can see for himself something of the application possible in engineering works about New York City. If one masters the principles well enough to use them in questions or on points usually considered obscure and that engineers or others want to know, then he is said to be practical and his geology is ranked with the applied sciences. In no wise, however, does it differ from the simple, plain science of geology. The facts are the same, the methods of reasoning are the same, the conclusions are exactly the same. The only difference is that some one else in addition to the geologist wants to know what the conclusions are. Some one wants to use the conclusion as one of the factors in some other problem. And some geologist is found who has a taste for problems arising in a field only partly lying within his own sphere of knowledge and control, and he is willing to word his findings in terms suited to them. This is applied geology.

The accompanying diagrams and maps represent graphically summaries of the latest and most complete data available. The geologic cross-section (Plate 1) gives an interpretation of the relations of the different formations to each other, and the general bed rock structure from the Palisades on the west side of the Hudson across Manhattan Island into Brooklyn. The rock-floor map (Plate 4) gives information on depth to bed rock at as many points as our data warrants. The whole, we trust, may be found more useful in this form than any series of individual applications that could be offered.

A long series of illustrated problems belonging to this region, many of which lie within the City limits, have been described by the senior author of this paper in Bulletin 146* of the New York State Museum at Albany. This is readily obtainable for any one sufficiently interested in such matters. For a detailed discussion of methods and application of geologic study to special cases the reader is referred to this work.

*"Geology of the New York City (Catskill) Aqueduct," by Charles P. Berkey. Bulletin 146. N. Y. State Museum. 283 pp. 1911, Albany, N. Y.

Problems of an applied character are probably as numerous and varied in New York City as in any area of similar size on the face of the earth. This is partly because of the exceedingly complicated and much obscured geology, and partly because of the large number and variety of projects that require exact data and wise judgment on questions pertaining to sub-surface conditions. However complex the discussion of local geology just given may seem to be, it is immensely more simple than the actual conditions themselves are. Every phase of the geology in all its complexity has its application to other problems and questions. Which phase is most important depends on the particular question at issue. The one that fits the case is the most important for the time being. A large part of a practical geologist's reputation is gained by appreciating which phase does fit, and by being able to distinguish between facts or data that have a bearing and those of no consequence in the case, and by being remorselessly consistent in reasoning from the applicable data and the known agencies and processes to the necessary conclusion as to final effects or original conditions.

Frequent questions arise involving the following points:

1. Artesian water supply and underground circulation.
2. Quality of rock for structural purposes.
3. Condition and kind of rock for tunneling purposes.
4. Position of contacts or changes from one formation to another.
5. Depth to bed rock and contour of the rock floor.
6. Character of drift and probable behavior in excavation.
7. Reliability of foundations.
8. Location of preglacial channels and their depth.
9. Kinds of explorations to make and probable extent required.
10. The spots where exploratory investigation will count for the most.

A considerable part of one's duty in applied geology lies in directing explorations so as to secure the maximum amount of information with a minimum of expense in time or money. There is such a thing as making a reasonable amount of exploration, but in a way that adds little to the useful data. The same work properly distributed would reveal the features of the critical spots and determine thereby whether or not the lines of reasoning were well

established. Another equally important duty is to advise against unnecessary exploration, or hopeless projects and to controvert erroneous hypotheses of local geologic conditions. In other words, much of one's work is preventive and advisory rather than constructive and developmental.

These remarks have no more to do with the geology of New York than with any other important district. They are intended chiefly to emphasize the point that geology applied to engineering problems differs not at all from plain, straight-forward, common-sense geology.

Configuration of the Rock Floor.

For very many purposes it is advisable to learn the depth to bed rock. No doubt thousands of borings have been made for that express purpose. And yet the mere fact that rock has been found which stopped the bore or that was penetrated a few inches is not sufficient evidence that the rock floor has been reached. Many cases where important matters depended upon an accurate determination of this point have been incorrectly reported. These are scattered through the records of private companies and city departments. Many can readily be detected as errors, while others cannot now be checked.

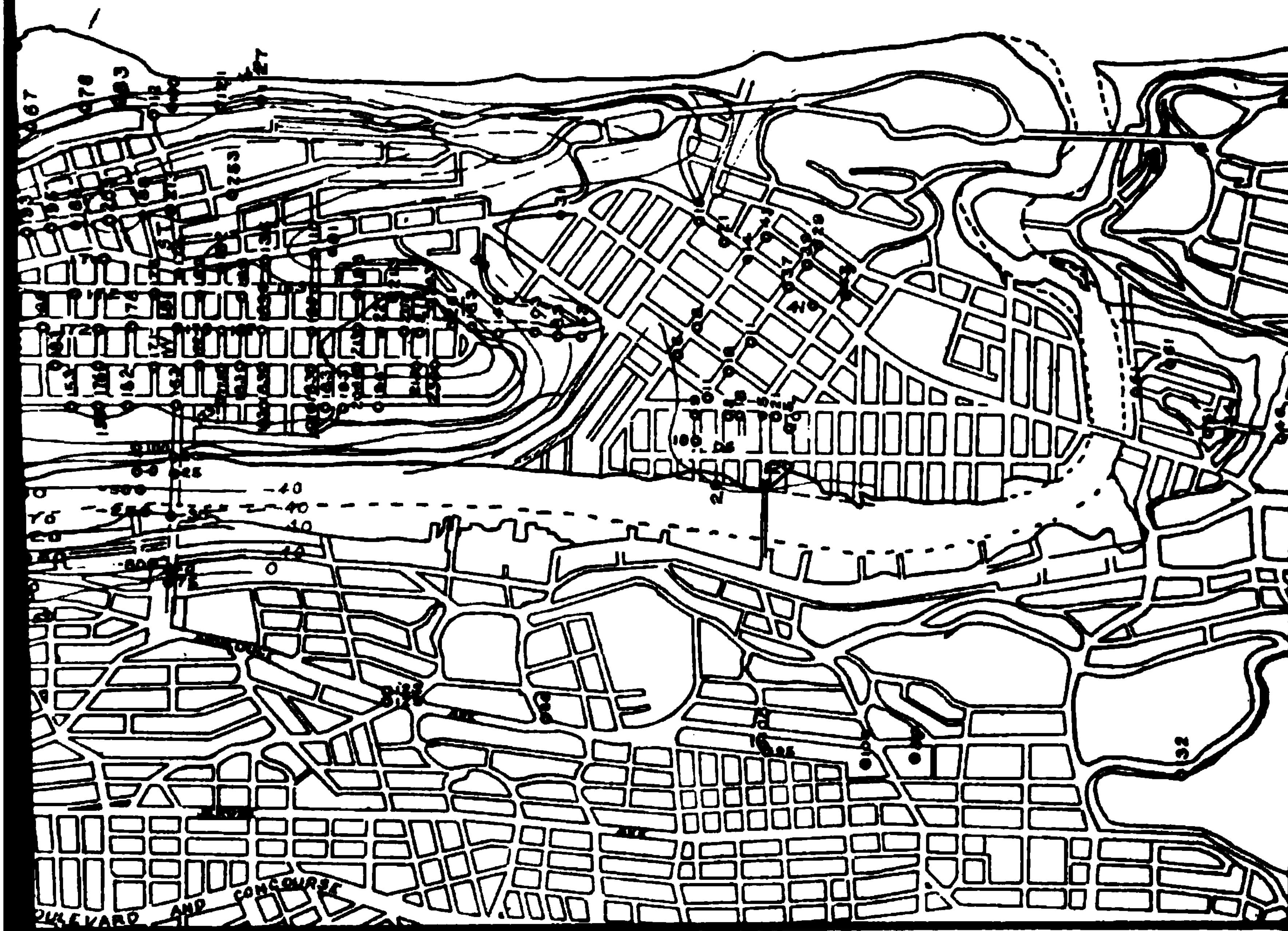
The chief requisites of a boring intended to discover bed rock are:

(*a*) To reach solid rock.

(*b*) To secure core or fragments of it which must agree in type with the formation that ought to lie in the floor at that point.

(*c*) To penetrate this rock a greater distance than could be represented by a loose boulder.

In many actual cases only the first of these requirements is met and it proves almost nothing. In still many others, where the second requirement was supposed to have been complied with, subsequent examination proves that the cores and fragments secured represent rock types that do not occur as bed rock at the locality and consequently must be from boulders. Many such are trap boulders carried in the drift from the Palisades. Of course, in all such cases nothing has been shown about the rock floor except that



BED ROCK ELEVATIONS
BOROUGH OF MANHATTAN
CITY OF NEW YORK

BASED ON BORINGS AND EXCAVATIONS

CHARLES P. BERKEY. JOHN R. HEALY.

1911

[T]O ROCK ○
[N]OT TO ROCK ●

U.S.C.&G.S. DATUM
MEAN SEA LEVEL AT SANDY HOOK.
CONTOUR INTERVALS, 40 FT.

it lies still deeper. Many others in this category represent boulders that are similar to the local rock floor and they therefore are more misleading than the others, because one necessarily ranks them higher and depends upon them more. Yet they are often far above bed rock. Too few borings comply with all the requirements. A boring that is not worth carrying to its completion, and data that are not worth studying critically enough to discriminate between foreign and local rock material had about as well not be made. Such work is often completed without even suspecting that the problem to be solved has not been touched at all.

In a place like New York City the question of depth to bed rock and its general contour is of more than usual importance. There are more and more frequent calls for information of any sort on this point. Some years ago most of the data then obtainable was summarized by Professor Hobbs* and a contour map was constructed by him which gives his interpretation of the rock floor. The basis of his work was a series of borings. Since that time there have been hundreds of additional explorations. Many sections of the City then wholly unknown have been reached by such investigations. In addition all of the older borings have been re-examined, the criteria for a satisfactory boring have been applied, and an identification of the character of rock in each one has been made. This latter study has resulted in a complete revision of the areal and structural geology of southern Manhattan, the East River and portions of adjacent Long Island. This revision and the data on which it is based, including a critical study of 300 borings, has been published by the senior author as a separate paper.†

These two earlier publications have formed the starting point in the study which is here presented. A summary and interpretation of all data bearing on this question of rock floor configuration has been reduced to the form of a map (see Plate 4). It shows the location of every boring and excavation known and accepted as reliable for such use. The elevation of bed rock above or below mean sea level is indicated at each point by suitable numbers. We have made a discriminating re-study of all data used in the present paper. This data as given, therefore, is not a mere compilation,

*"The Configuration of the Rock Floor of Greater New York," by W. H. Hobbs, Bulletin 270, U. S. Geol. Surv., Washington, 1905.

†"Areal and Structural Geology of Southern Manhattan Island," by Charles P. Berkey, Annals N. Y. Academy of Sciences, Vol. 19, No. 11, pt. 2, April, 1910.

but represents our judgment also as to the validity of the figures themselves. In addition an attempt has been made to extend the application of these facts and the scope of the map by giving our own interpretation of them by means of contour lines.

SUMMARY.

Two objects have been kept constantly before us in the preparation of this paper. One is a comprehensive statement of the geology of New York City, and the other is a piece of investigation of general usefulness in practical affairs.

The first object was to describe the local geologic features, with their origin and history, in a way that would make their mastery easy and their bearing upon many engineering questions plainly apparent.

The second object has been to revise all available data bearing upon the question of rock-floor configuration in Manhattan, and to summarize and interpret them in a form more convenient and useful for engineers. The accompanying map, Plate 4, shows the facts and also the interpretation of these data.

We trust that both parts may be found useful. In both the geology of New York City as used by engineers or for other practical purposes has been brought up to date.

DISCUSSION.

THOMAS C. ATWOOD, M. M. E. N. Y.—Dr. Berkey has presented a most valuable paper and one to which little can be added from the geologist's point of view. His collation of information is exhaustive and his interpretation of the conditions developed by the borings is based upon the most thorough study. The speaker therefore will take up only the engineering side of one of these problems, giving the method of laying out the borings so as to secure the information on which to base the final layout and design of tunnel. This is in connection with the proposed distribution conduit for the Catskill water.

Throughout the greater part of Manhattan the rock floor was known with sufficient certainty to admit of the tunnel line being laid out at once when the general route was decided, and hence it was only necessary to follow this line out and investigate spots where the rock might be at a low elevation through local decay or erosion, so that the tunnel might be at a safe distance below all such depressions.

The depressions in the rock floor usually correspond to surface depressions and are denoted by ponds and streams if of sufficient size. Over a large part of Manhattan the surface has been so altered by buildings and graded streets that the original surface depressions have been obliterated and much use was found for General Vielé's map of Manhattan, prepared in 1874. By its use a number of the old streams were located and the rock depressions coresponding were measured by borings.

At several places, however, the depth and character of the rock were so much in doubt that some exploration had to be made before the line could be laid out definitely, when the remaining borings were placed on the tunnel line, with one small exception. This was along the Speedway where the rock cliff rises abruptly near where the schist meets the limestone and the tunnel line runs just back of the cliff. Here it was thought best to put in a couple of holes at critical points to make sure that the cliff was not underlaid by decayed rock, due to some unexpected change in dip in the limestone. These holes developed sound rock.

The most doubtful places were the Harlem River crossing, the Manhattanville region, the stretch between Morningside Park and Central Park, and the lower East Side. Some exploratory holes were also put down in Brooklyn, but this was to determine the length of the line rather than its location, it being known that the rock floor in Brooklyn sloped off to the south, and hence it was only necessary to find how far the tunnel could be carried and still be able to put down the terminal shaft under air pressure to the rock.

At the Harlem River crossing there was considerable information available from the borings put down by the Aqueduct Commission in exploring for the New Croton Aqueduct, which crosses the river about 2 200 ft. north of where we expected to cross it. The results of these borings were well borne out when the tunnel itself was excavated and all this information was at our disposal. It was accordingly necessary to explore only to find out exactly where the contacts between the limestone and gneiss on one side, and the schist and limestone on the other side were, and the depths of decay at these points. No unexpected conditions were found; consequently, the line was located practically where it was originally laid out.

In the Manhattanville region a deep depression was found, but the rock, while somewhat shattered, was sound and the original line was adhered to at this point.

Between Morningside Park and Central Park a long anticline was developed which proved to be badly decayed on top to a prohibitive depth at One Hundred and Tenth Street and One Hundred and Eighth Street, but sound rock was found at One Hundred and Sixth Street, and the tunnel was accordingly located there.

On the East Side no previous borings had been made near the line of the tunnel, but from results of the few borings made by the Bridge Department and the outcroppings on Blackwell's Island and above to the northward, together with a rigid application of the geological principles outlined in the foregoing paper, Dr. Berkey predicted that several formations would be found and a poor condition of the floor might be expected. Dr. Berkey's predictions were well borne out by the borings. Most of the formations he expected were found in the locations designated.

It had previously been considered that the schist formation covered the whole lower end of the island and at a moderate depth, and the first contract for making the borings did not provide for sinking casing more than 200 ft., which was believed to be amply sufficient.

In order to explore this region thoroughly another contract was let, in which the depth to which casing should be carried was not limited and the work was carried on under this and a succeeding contract of the same nature.

After the preliminary holes on the East Side had been drilled along the line originally laid out, a second line through Sixth Street was investigated, but conditions here proved to be little or no better than on the more direct line, so the original line was used.

Throughout the work Dr. Berkey has kept closely in touch with it and his advice has been of the greatest assistance to the engineers in its economical prosecution.

ALFRED D. FLINN, M. M. E. N. Y.—The studies and explorations for the City tunnel of the Catskill aqueduct were carried out under the general direction of the speaker. There is one feature of this work and of the work of drill exploration in general that appeals to me as worthy of more serious attention than it has hitherto received, viz.: the permanent, general value of these boring samples after they have been obtained. We engineers sometimes forget how much money borings cost and that they have not only a temporary value in helping to solve the problem in connection with which they were made—whether to determine the depth to rock, or the nature of the material over the rock, or the character of the rock—but that at some future day the same information may help to solve similar or quite different problems at that point, or much broader problems. I want to make a plea for the permanent, available preservation of all such samples, properly labeled and properly described, in such a way that a man like Dr. Berkey, or men like ourselves, can get at them 5, 10, 25, 50 years afterwards, and use them with assurance. Personally I am endeavoring to have the large body of such information collected by the Board of Water Supply preserved permanently in a suitable record building, along with other records. Whether we shall succeed remains to be seen. I think the endeavor is worth making because of the first cost and probable future value of the materials thus secured.

A suitable repository for drill cores, samples of materials overlying the rock and notes relating to drilling operations might, perchance, be established in the American Museum of Natural History. Here all City departments might be required or requested to deposit all such materials now in their possession and to send with reasonable promptness all those obtained in the future. Corporations and private individuals should be encouraged to make similar use of this repository. All information here assembled should be freely available to all parties having use therefor. It might not be necessary to store all the core or all the earth samples taken from a hole, for skillfully selected portions, with proper notes, would serve the purpose equally well and require much less space, besides being more convenient for future reference. This Society could perform a useful service to the City by appointing a suitable committee with power to take this matter up with the proper officials and pursue it until the cores and samples were actually deposited, properly labeled and catalogued.

CHARLES P. BERKEY, M. M. E. N. Y.—I am glad that some of the most important special features of the Catskill distribution conduit have been brought up by Mr. Atwood. It would have been a real pleasure to discuss some of the problems of that immense project in detail at this meeting, but the normal limitations of

time will not permit the handling of so large a field. It has seemed to me more profitable at this time to discuss the broad geological principles upon which all special studies are based. There is an almost endless detail and variation in their application, but often all the principles are of most importance for men who want to draw conclusions for themselves.

A rather full discussion of applied geologic studies made in connection with the choosing of the Catskill distribution conduit line and subsequent explorations is now in press, and is to be issued as Bulletin 146 of the New York State Museum, Albany. This will be available to engineers in a short time. For New York City, Bulletin 146 may be regarded as supplementary to the paper presented this evening.

I am in most hearty accord with Mr. Flinn in his efforts for proper preservation of materials gathered in explorations. Critical analysis of data, accurate record of observations, suitable publication of interpretation and conclusion or opinion and recommendation are all of immediate importance and usefulness, and they readily attract attention. But it is sometimes overlooked that the same material may have still other bearings; they are probably capable of throwing light upon other cases or future problems, the nature of which is not yet fully grasped.

As a case in point, I would call attention to the recent revision of the geology of southern Manhattan, especially of the so-called Lower East Side district mentioned by Mr. Atwood, and the East River. That revision, as originally made in a special report to the Chief Engineer of the New York City Board of Water Supply, was based wholly upon the evidence of materials gathered originally for other purposes. Some of these were borings made by the Dock Department many years ago, at a time when the different rock formations and their relations were not understood. They gave the immediate information wanted at that time (depth to rock), and might have been destroyed by men of less insight into their significance. A re-study of these old borings showed that some had not reached bed rock at all, others had penetrated the standard Manhattan schist as it is now known, and still others had penetrated an entirely different formation, the Fordham gneiss, which until recently was not supposed to occur in southern Manhattan. Certain borings of the Bridge Department and of the Public Service Commission gave similar evidence. By reducing these facts to a form consistent with the geologic character of the district, a revision of the geology was made for that portion of the City wholly covered with drift, and explorations have since been planned in accord with the new views. The essential corrections of the revision is now established and a corrected geologic map is available.

A tabulation of the 300 borings on which this study was made has been published in the Annual of the New York Academy of Sciences under the title, "Revision of the Areal and Structural Geology of Southern Manhattan Island."

This is a use not originally contemplated in the making of any of these borings. But the materials were saved and the subsequent conclusions drawn from a re-examination of them have controlled the whole scheme of exploratory investigations for the distribution conduit from Central Park to Brooklyn. They controlled the choice of point for crossing the East River, which was found to be in exceptionally good condition. It would have cost the City many thousands of dollars to have undertaken this work without such help.

It is more than likely that our own materials, if properly preserved, will serve future uses as well. It is all very agreeable to believe that we have delved to the very bottom and have laid bare all secrets and have explained or interpreted all obscurities and have formulated an explanation that is complete in itself for all time. But no one has yet accomplished so much. In addition to giving our own interpretation and making our own application, it is an equal duty to preserve exploratory materials for future study.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 63.
PRESENTED MARCH 22D, 1911.

A PROPOSED METHOD OF INTERPRETING THE ELEVATIONS OF ALL PORTIONS OF A STREET SURFACE FROM THE ESTABLISHED GRADES.

BY VERNON S. MOON,* M. M. E. N. Y.

WITH DISCUSSION BY
HENRY W. VOGEL, AMOS L. SCHAEFFER, GEORGE W. TUTTLE, H. D. APPLEBY, EDWIN H. THOMES, SAMUEL C. THOMPSON, H. L. OESTREICH, EDWARD M. LAW, JR., ARTHUR S. TUTTLE, AND VERNON S. MOON.

Under the provisions of The Greater New York Charter the President of each borough is directed to prepare a map of the territory over which he has jurisdiction, for which a map has not been previously adopted, laying out streets, etc., and indicating the width and grades of all such streets.

The problem of clearly indicating the position of a street, in so far as its location affects the horizontal plane, is simple, and the methods are practically similar in the various boroughs. In the vertical plane, however, the methods of indicating the grades of streets differ in each borough, permitting of considerable variation in their treatment.

* Assistant Engineer, Board of Estimate and Apportionment.

METHODS OF INDICATING AND INTERPRETING GRADES.

An examination of the maps prepared under the jurisdiction of the Borough Presidents and submitted for the approval of the Board of Estimate and Apportionment, shows that in the Borough of Manhattan it is customary to prepare a map consisting of a plan and also a profile along the center line of each street. In the Borough of Brooklyn the elevations are shown in the middle of intersecting streets when the grades are comparatively level, and in the case of steeper streets opposite the building lines usually of one street only. These plans contain a note indicating that the elevations refer to the intersection of the curb tangents at street intersections and to the top of the curbs at summits. The Borough of the Bronx usually indicates a level platform for the area enclosed within lines at right angles to the street lines, and passing through the intersections of the curb tangents providing the greatest platform area, except in some instances when the transverse sidewalk slope on the lower side opposite a building line corner would be excessive, when the platform area is increased to comprise the space within lines at right angles to the street lines at the building line corners of one or both of the intersecting streets. In the Borough of Queens the elevations are placed in the middle of the streets, with no note or indication as to their treatment or points of application. The maps submitted for the Borough of Richmond show elevations for every street at the intersection of the curb tangents, and also at all other points where it is proposed to have a break in the curb grade when the street is improved.

A comparison of these methods of indicating grades shows that a different method is employed in each borough. There is no general ordinance in effect in this City for interpreting these grades, but each borough probably has some fairly well defined rule for this purpose. In none of the boroughs, however, are these rules fixed by ordinance, and there can, therefore, be no assurance that they will be adhered to.

Ordinances have been adopted by the Board of Aldermen for some of the boroughs providing a standard transverse sidewalk slope, but it is impracticable to conform with its provisions adjoining street intersections except under very favorable circumstances.

Buildings erected for business purposes are considered particularly desirable if provided with an entrance at the sidewalk level, but under the present method of determining elevations for a street, prior to the grading by the City, it is difficult, even with the assistance of a City Surveyor, to predict just what treatment will be given except where a low rate of grade exists.

The Corporation Counsel has recently informally raised an objection to the manner in which grades are at present shown on maps for laying out streets in this City. He also cites a court decision to the effect that "the map filed must clearly and unmistakably indicate the grades of the street, and in no portion thereof must it be left in doubt or to be inferred from the grades of other streets or from anything else," and has suggested that hereafter the maps prepared for establishing grades should clearly indicate the elevation at each alternating lot line, or that some other method should be adopted which would obviate the objection raised, and prevent in so far as possible claims for damages in this connection.

An examination of the improved streets in each borough shows that the interpretation by the Highway Bureaus of the present methods of indicating grades has been generally good. Numerous cases exist, however, where it has been necessary for the Engineers in charge of the grading improvements to adjust the surface of the street to fit in so far as possible the entrances of buildings already erected, as well as to meet the elevations of receiving basins and manholes, located by private survey or by the Sewer Bureau, rather than to follow his best judgment in properly improving the street. In many instances these adjustments have been carried to such an extent as to result in a departure of several feet from the established grade with the intention of having a map approved at some subsequent date legalizing the elevations of the street surface as improved. In some instances when the legal grade has been departed from it has resulted in a heavy award for damages, not only to the owners of buildings at the legal grade, but in many cases to the owners of buildings whose property was benefited to some extent at least by the attempted adjustment. Notwithstanding the discretion that is exercised by the engineers in charge of the grading improvements, numerous claims are granted by the Board of Assessors for damages to buildings which were erected after the

PLATE 5.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.

Fig. 1.—Northerly Corner of Cedar and Sedgwick Avenues, Bronx, Showing 20% Slope Along Sidewalk Connecting Streets Having a Maximum Grade of 6 Per Cent.

Fig. 2.—Northerly Corner of Third Avenue and Boston Road, Bronx. Retaining Wall Carried Through Nearly to Curb Corner, Reducing Sidewalk Space from 18 Feet to 6 Feet.

map fixing the street grades had been approved, but the entrances to these buildings did not bear the intended relation to the street surface as improved through a misinterpretation of the street grades by the builder or his engineer. Particularly is this true at the corners on streets having a considerable grade or intersecting at an acute angle.

I am informally advised by a member of the staff of the Board of Assessors that it is customary to award damages in all cases where there is any appreciable difference between the street surface and the entrance to the building, providing in the claim therefor it is shown that the property owner took the precaution to employ a City Surveyor to give him the grades and followed his advice in the matter.

It therefore appears that the City and the property owners are put to considerable expense incidental to regulating and grading streets, which is due in part to the present incomplete method of indicating on the City map or fixing by ordinance the elevations of all parts of the street surface. No practical solution of the problem seems to have been adopted in this City which would definitely determine all of these elevations, and an examination of the text books covering this subject reveals no well-defined general rule for determining grades at street intersections. Practically all of the authorities on the subject, however, agree as to the advisability of an ordinance fixing the same. The following paragraph is quoted from "Streets and Pavements," by Mr. George W. Tillson, M. M. E. N. Y.: "It can be laid down as a fundamental principle that the elevations should be so fixed that there shall be no question in the mind of any engineer as to the established grades of any piece of property, its exact elevation being simply a mathematical calculation."

Plates 5 to 9, inclusive, illustrate some extreme methods of treatment of street intersections in this City, due largely to a misinterpretation of the street grades caused either by the absence of sufficient elevations on the grade chart or the lack of some definite method for properly interpreting them.

Approximately two years ago, under the supervision of Mr. Arthur S. Tuttle, M. M. E. N. Y., Engineer in Charge of the Division of Public Improvements of the Board of Estimate and Apportionment, the author endeavored to formulate a rule for

determining the elevations of the street surface from the established grade, which was published in the 1908 Annual Report of the Chief Engineer of that Board and in some of the engineering periodicals. An exhaustive study could not then be made with the limited time available, and the method formulated was presented for the purpose of discussion, and it was hoped that the engineers interested in this kind of work in the various boroughs would co-operate and endeavor to perfect this or some similar method.

The attempt to promote a thorough discussion of the subject was only partially successful, a few engineers having shown some interest in the matter and some minor suggestions having been made. The general conclusion seems to have been, however, that practically no one has had the available time to give the subject extensive study. The necessity for the adoption of some method of determining these elevations is continually arising and the author has recently made a more complete study of the subject than that previously presented, due consideration having been given to the criticisms and suggestions which have been made. This has resulted in some slight modifications of the original rule, but in no radical changes. Realizing that the practicability of any method adopted depends largely upon the time required to apply it, an attempt has been made to simplify the computations as much as possible.

It may be that the proposed rule will not be adaptable to the needs of every case presented, and it is probable that some modifications may still be found advantageous. It is suggested that for those few cases where it does not provide suitable treatment, that sufficient elevations or symbols could be shown on the grade chart, which, in connection with the proposed rule, would enable any engineer to derive all the other necessary elevations. Particularly is this desirable in diagonal streets and wide thoroughfares in general, which it is usually advisable to carry across streets of lesser importance with a uniform grade.

In formulating the method now presented consideration has been given to the convenience of traffic, drainage, the appearance of each of the intersecting streets, and to the avoidance of abrupt changes of grade. Particular attention has been given to avoiding damage to the adjoining property at the corners by flattening the street grades so as not to necessitate excessive transverse sidewalk

PLATE 6.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.

Fig 1.—Easterly Corner of Hopkinson and East New York Avenues, Brooklyn. Difference in Elevation Between Sidewalks at Building Corner of 20 Inches; Connected by Steps and Sharp Incline.

Fig. 2.—Westerly Corner of Park Place and East New York Avenue, Brooklyn. Showing a Difference in Elevation Between Sidewalks at the Building Line Corner of 15 Inches.

slopes or the placing of a step in the sidewalk at these points. Inasmuch as the corner property is the most valuable, it has been considered advisable to make its protection one of the controlling features even at the expense of a slight increase in grade within the block.

Numerous cases exist where surface improvements have been carried out on the line of a street without regard to the effect on the treatment of those which intersect it, but the conditions of the proposed rule provide that proper consideration be given to all intersecting streets.

Attention is called to the fact that, in the same borough, it has been customary to treat street intersections of precisely a similar character in different ways. Thus, in some cases the grade of each of the intersecting streets is carried unbroken across the intersection; in other similar cases only one of the street grades is flattened, and in still others a level platform is used within the area enclosed by the extension of the curb lines or building lines. This variation in treatment is unquestionably due partly to a difference in interpretation and partly to an attempt to meet physical conditions existing at the time the streets were improved.

It is to be hoped that in the future it will be possible to map the outlying sections of the City considerably in advance of the building improvements and that property owners will become educated to the necessity of instituting proceedings for acquiring title to streets at an early date, so that the grading by the City can be carried out in advance of the improvement of the abutting property. This policy has been recently followed to a considerable extent in the Borough of the Bronx, where grading improvements have been instituted for a number of wide streets, in several instances two or three miles long and for the greater portion of their length the abutting property is almost entirely unimproved.

Outline of Proposed Method.

The method now presented is based on using what is designated as either the "Curb Line Treatment" or the "Building Line Treatment."

Under the former a level platform is to be used for the area enclosed within lines joining the intersections of the curb tangents

for all cases where the street grades as originally computed between established elevations are 3% or less, a 2% transverse sidewalk slope being used whenever practicable, the maximum rate being 6 per cent.

Under the latter treatment, the grades of all portions of streets producing transverse sidewalk slopes in excess of the maximum at any building line corner under the "Curb Line Treatment," and the grades of all streets in excess of 3% as originally computed, are to be flattened within the area bounded generally by the street lines and by lines at right angles to the center lines and passing through the building line corners giving the greatest platform area and as follows: If the intersecting streets are of equal width, the grade of the one traversing the shorter block length is to be reduced one-third and that of the other two-thirds. If the streets are of unequal width, the grade of the wider street is to be reduced one-third and that of the narrower street two-thirds. From these reduced grades the elevations at the boundary of the platform are computed; similarly the elevations for the remaining streets, if any, are to be computed from the original grades if not herein required to be flattened. For all cases in which the original grades on both streets adjoining a building line corner are 6% or less, the maximum transverse sidewalk slope is to be 6% and for all other cases 10 per cent.

If the elevations above computed for the center lines opposite the building line corners do not result in transverse sidewalk slopes in excess of the maximum, they are retained; otherwise the excess in elevation over that required to provide the maximum is to be removed by adjusting in direct proportion to the grades used in computing these elevations. Provision is made for varying the elevation of the curbs with respect to the center line to provide proper crowns for various roadway widths. The roadway of the more important street is to be graded with a longitudinal slope across the intersection, but approximately level so far as its transverse cross section is concerned.

Description of the Proposed Rule.

Without attempting to read the rule in full, a synopsis of the principal features will be given and then its application demonstrated.

For the sake of clearness in the discussion, definitions have been given to certain parts of the street intersection, these comprising Paragraph 1 (page 6), and also shown on Plate 10, as follows:

The Center Line Intersection is defined as the point of intersection of the center lines (Plate 10, Point *"c"*), except in the case of the center lines not meeting at a common point, when it comprises the area within the center lines at their intersection (Plate 10, area *"c, c, c"*).

The Curb Line Platform consists in general of the area included within lines joining the intersection of the curb tangents (Plate 10, areas *"a, a, a, a"*).

The Building Line Platform comprises in general the area contained within the extension of the building lines in rectangular intersections, and in other than rectangular intersections the area within lines at right angles to the center line and passing through the acute-angled building corner, or through the corner giving the greatest platform area (Plate 10, areas *"A, A, A, A"*).

To follow the application of the rule clearly, these definitions should be borne in mind:

Paragraph 2 defines the Elevation Fixing Grades as applying to the Center Line Intersection, unless otherwise indicated on the map.

Paragraph 3 describes the method of treating the Center Line Intersection in those few cases where it comprises an appreciable area.

Omitting for the present any reference to Paragraphs 4 and 5, some of the succeeding paragraphs will be taken up.

Paragraph 6 provides for a maximum longitudinal slope along the center line of 4% within the limits of the Curb Line Platform. Under the provisions of the rule this maximum rate will only be used occasionally, and on streets having a grade in excess of 6%; and in these cases, if it is desired to provide a greater slope than the maximum, this can be done by indicating a uniform grade between established elevations. Provision is also made in this paragraph for a uniform grade between elevations established within the limits of the Building Line Platform.

In Paragraph 7 provision is made for a 2% transverse sidewalk slope whenever practicable and for a maximum transverse sidewalk slope of 6%, except in those cases where the street grade as origi-

nally computed on any street adjoining a building line corner is more than 6%, when the maximum shall be 10% for either street, opposite the said corner. If for any reason the transverse sidewalk slope at the building line corner is more or less than 2%, it shall be made to agree with the latter rate at a point 25 ft. distant from the building line corner. The maximum transverse sidewalk slope controls to a large extent the rate of grade of intersecting streets adjoining the corner, and in deciding upon these maximum slopes an attempt has been made to keep them as high as practicable, and at the same time make it possible to flag the entire sidewalk space at reasonable grades whenever the importance of the streets justifies improving the full sidewalk width.

The author believes that the center lines of intersecting streets are the proper basis of calculation for computing elevations, and in the method herein described the elevations of the center lines are first determined, and from these are derived the elevations of the curbs and building lines. In order to obtain proper crowns for the pavement for different roadway widths it will be necessary to vary the elevation of the top of the curbs with respect to points immediately opposite on the center line, as described in Paragraph 8.

Paragraph 9 provides for a standard depth of gutter whenever practicable of 0.4 ft., or approximately 5 in.

Considering a cross section of a street surface, the following table shows the corrections to be applied to the elevation of the center line to determine the elevations of the tops of the curbs for various roadway widths, and also the resulting crowns when the standard depth of gutter is used.

Roadway Widths.	Elevation of Center Line to Tops of Curbs.	Depth of Gutters.	Crowns.
24 ft. or less	+ 0.1 ft.	0.4 ft.	0.3 ft. = 3⅝ in.
From 24 ft. up to and including 34 ft.	0.0 ft.	0.4 ft.	0.4 ft. = 4¾ in.
From 34 ft. up to and including 44 ft.	− 0.1 ft.	0.4 ft.	0.5 ft. = 6 in.
From 44 ft. up to and including 54 ft.	− 0.2 ft.	0.4 ft.	0.6 ft. = 7¼ in.
From 54 ft. up to and including 64 ft.	− 0.3 ft.	0.4 ft.	0.7 ft. = 8⅜ in.

It will be seen that Paragraphs 8 and 9 determine to a certain extent the amount of crown to be used for various roadway widths.

PLATE 7.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.

Fig. 1.—Amsterdam Avenue, Looking Westerly Along 123rd Street, Manhattan. 8% Slope on Former Street Carried Unbroken Across the Intersecting Street.

Fig. 2.—Intersection of Jewett and Maine Avenues, Richmond. 6% Slope on Former Street Carried Unbroken Across the Latter, Crown Shifted Towards Higher Curb, Resulting in a 15% Slope to Gutter on Lower Side.

although this is not definitely fixed owing to the depth of gutter, being subject to variation whenever necessary. In all probability it will seldom be desirable to use a lesser amount of crown than that indicated above, and if it is desired to use a greater amount the depth of gutter can be increased to provide for same.

It is proposed to fix the elevation at the intersection of the curb tangents from that of a point immediately opposite on the center line of the wider street or the street traversing the shorter block length, if they are of equal width, allowance being made for the difference in elevation previously described between the center line and the tops of the curb.

Paragraph 10 indicates the method to be used for curb grades at corners. The tangents in the curb within the limits of the Building Line Platform are to be graded uniformly between the elevations fixed for the curb at the boundaries of the said platform and the elevation determined for the intersection of the curb tangents.

The curve formed in the curb joining the tangents shall be graded uniformly between the elevations of the curbs at the points of curvature.

Paragraph 11 provides for a uniform grade between the exterior boundaries of the platforms used or between a platform and an intermediate established elevation.

Having covered all of the fixtures, we will now return to the actual method of treating a street intersection as covered by Paragraphs 4 and 5, considering at first Paragraph 4, which deals with streets having a light grade as illustrated by Plate 11, Intersection "A." The elevations shown on the plates herewith are given to the nearest tenth of a foot, scaled distances having been used, the latter being sufficiently accurate for all practical purposes. In connection with nearly all the computations to be made considerable time will be saved if a slide rule is used.

Curb Line Treatment.

Under Paragraph 4 the Curb Line Platform is to be used, subject to two general conditions. First, the grade of each of the streets forming the intersection must be 3% or less; and second, the transverse sidewalk slope on the lower side opposite any building line corner must not exceed 6 per cent.

It is assumed that streets having a grade of 3% or less are in general adapted to a level platform at their intersection.

For the sake of simplifying the explanation in this case, intermediate elevations have been established for both streets in each direction from the intersection.

The first step in calculating the elevations at any intersection consists of determining the rate of grade between established elevations for each street immediately adjoining the said intersection.

The rate of grade between the elevation at the intersection of the center lines and the nearest established elevation in each direction having been computed and found to be less than 3%, we make the elevation at the point of intersection of each center line with the Curb Line Platform the same as the elevation at the Center Line Intersection. This determines the elevation of the center lines within the limits of the Curb Line Platform, and the next step is to compute the final rate of grade along the center line, outwardly from the intersection, as fixed between the elevations above determined at the boundaries of the Curb Line Platform and their respective established elevations. From these last rates of grade are computed the elevations of the center line of each street opposite the building line corners, and directly opposite these points we determine the elevation of the top of the curbs as indicated in Paragraph 8.

In the case under discussion one of the streets has a width of 60 ft. and the other a width of 80 ft., with corresponding roadway widths of 30 ft. and 44 ft., respectively. According to Paragraph 8 the top of the curbs at and outwardly from the Building Line Platform in the former street are to be at the same elevation as points immediately opposite on the center line. and in the latter street 0.1 ft. lower than points immediately opposite on the center line.

Considering now the transverse sidewalk slope and the resultant elevations at the building lines we find by reference to Paragraph 7 that whenever practicable the sidewalk is to slope upwardly from the curb to the building line at the rate of 2%; this rate being applied to the elevation of the curb which produces the higher elevation at the building line corner. The maximum allowable transverse sidewalk slope applicable to this case is 6 per cent.

PLATE 6.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.

Fig. 1.—Southwesterly Corner of Loring Place and Fordham Road, Bronx. Showing 20% Slope Along the Sidewalk on the Former Street, the Maximum Slope Within the Block Being 11 Per Cent.

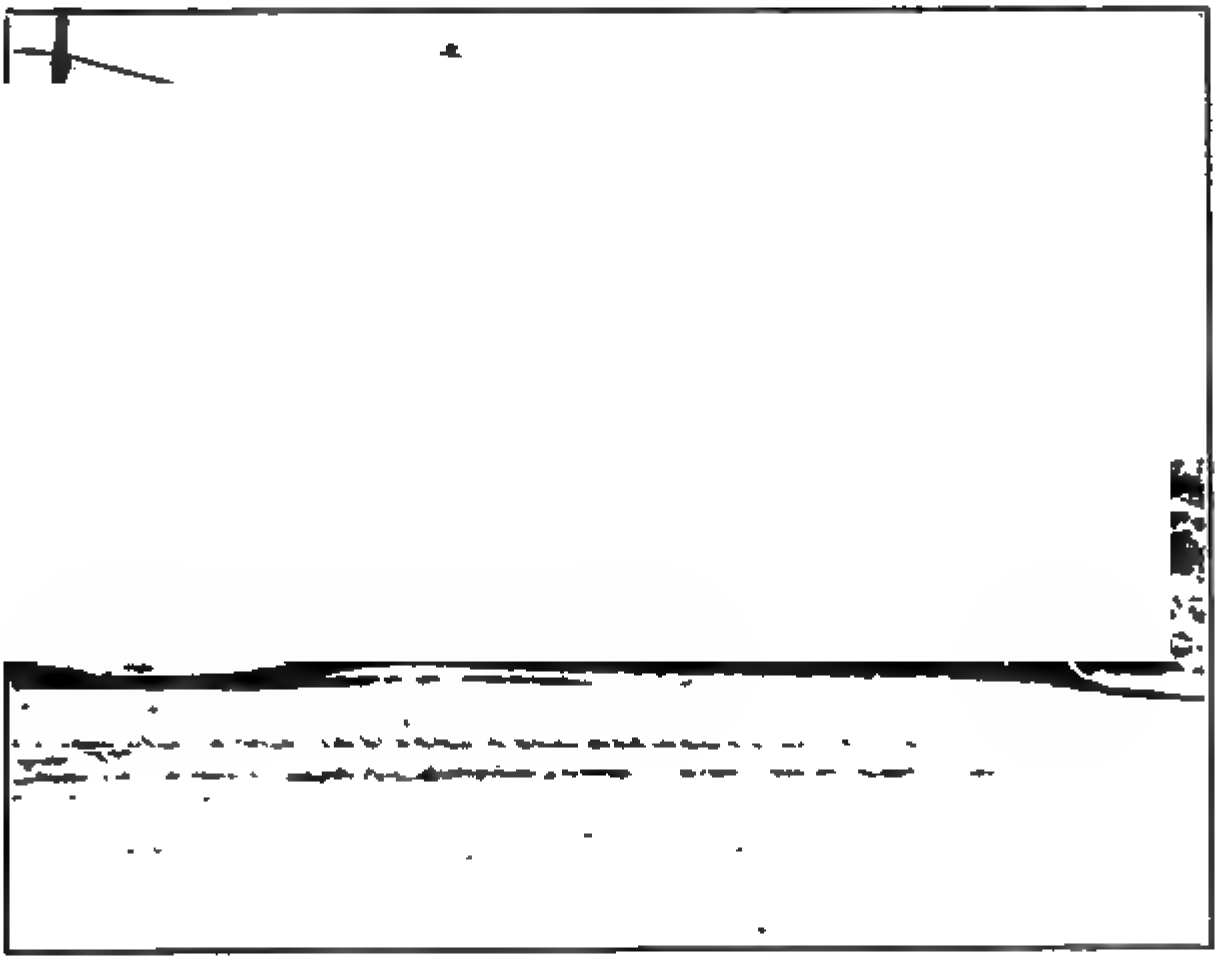


Fig. 2.—Davidson Avenue, Looking Northerly from Tremont Avenue, Bronx, Showing Difference in Interpretation of Grades. Manholes Set From 12 Inches to 18 Inches Higher Than Grade Determined for Curbs.

Having calculated the elevation of each building line corner and the resultant sidewalk slope on the lower side opposite it, we find that in no case does it exceed the maximum above referred to. The result of this last operation determines finally that the elevations computed are consistent with the rule governing the Curb Line Treatment, but if the resulting rate of grade across the sidewalk opposite any building line corner had exceeded the maximum, then the elevations thus far derived would have been abandoned and the entire intersection would be subject to the Building Line Treatment. The latter part of Paragraph 7 provides that if the transverse sidewalk slope opposite any building line corner is more or less than 2%, this latter rate shall be resumed at a point 25 ft. distant from the building line corner, the elevation of the building line being computed from that of the top of the curbs as indicated on the plate referred to. Paragraph 8 provides that the elevation at the intersections of the curb tangents are to be determined from the elevation of the center line of the wider street at a point immediately opposite the said intersection, subject to any correction in elevation between the center line and the curbs as provided in the paragraph of reference. The curve formed in the curb joining the tangents is to be graded uniformly between the elevations of the curb tangents at the points of curve. This last operation completes all the elevations required to properly improve the street surface and also the adjoining property.

Under practical conditions intermediate elevations within the block, as assumed for this intersection, will seldom be established, and in these cases it will be necessary to determine approximate elevations for each intersecting street at the adjacent intersections to arrive at the final rate of grade within the block, and to enable the elevations of the center line, curbs and house lines to be computed on these streets. Attention is directed to the slight increase in grade of streets within the block as finally computed. After some experience has been gained in the use of the rule, it is possible by a simple inspection of the adjoining intersections to estimate close enough for all practical purposes what the final rate within the block will be, inasmuch as this rate is only applied for the short distance from the intersection of the curb tangents to a point opposite the building line corner, for the purpose of setting the curb returns on the intersecting streets.

It may be undesirable in some instances to have a level platform at all intersections where the original grade is 3% or less, but this treatment could be abandoned by indicating upon the map a uniform grade for any street across the intersecting streets, if by reason of its greater width or location it was deemed to be more important than those which intersect it. Care should be exercised when establishing grades in this manner lest the conditions thus imposed should create excessive transverse sidewalk slopes, particularly when the streets so treated have grades in excess of 3% or intersect the other streets at an acute angle.

We shall now consider those intersections which under the rule are subject to the Building Line Treatment.

Building Line Treatment.

The latter part of Paragraph 4 provides that if the resulting sidewalk slope on the lower side opposite any building line corner exceeds 6%, the Building Line Platform shall be used as a basis for computing grades as described in Paragraph 5.

Paragraph 5 also provides for flattening the grades of all streets which have a slope greater than 3% as originally computed, the extent of this flattening being controlled by the maximum allowable transverse sidewalk slope opposite the building line corner, and the relative amount each street is flattened being dependent upon its width or relative block length, and rate of grade.

In treating rectangular intersections with streets having a grade in excess of 3% and acute-angled intersections with a lower rate of grade, where there is a descending slope along the roadway around any building line corner, an excessive transverse sidewalk slope is introduced on the lower side opposite this corner. Thus, if we assume two 60-ft. streets forming a rectangular intersection, and having a uniformly descending slope of 3% along the curb around the building line corner, we shall have applied this rate of grade for a distance of approximately 30 ft., from a point on the higher curb at right angles to the building line at the corner to a corresponding point on the lower curb. This results in a difference in elevation between these points of 0.9 ft. Applying now a 2% transverse sidewalk slope from the curb on the upper side to the building line corner (a distance of 15 ft.), we have a difference

in elevation between this corner and a point immediately opposite it on the lower curb of 1.2 ft. Obviously this difference in elevation for a 15-ft. sidewalk necessitates an 8% transverse sidewalk slope, which undoubtedly is excessive for streets having a longitudinal grade of approximately 3 per cent. In order to obtain some definite point where in a large majority of cases it will thus be necessary to reduce the grade of one or all of the intersecting streets, it has been arbitrarily assumed that all streets having a grade in excess of 3% as originally computed shall be flattened within the limits of the Building Line Platform and also the portions of all other streets where the original conditions as determined by the Curb Line Treatment, previously described, creates transverse sidewalk slopes greater than those fixed as the maximum in Paragraph 7.

Owing to the long tangent distances along the curb within the limits of the Building Line Platform opposite acute-angled corners, it is evident that even with flat grades it will in general be possible to use the Curb Line Treatment only in those instances where the intersection is approximately rectangular.

An investigation of the streets requiring a flattening of the grade at their intersections indicates that there are two general classes: first, the intersections formed by streets of unequal width, and, second, the intersections formed by streets of equal width.

No doubt it will be conceded that the grade of the street having the greater importance should be flattened the least across the intersection, and in treating streets in the first class it has been assumed that their width is a fair measure of their importance. In the second class, where the streets are of equal width it is proposed to flatten the grade of the street traversing the shorter block length the least within the limits of the intersection, for the reason that this reduction in grade across the intersection results in a greater increase in the grade of the shorter block than an equal reduction would in the grade of the longer block. Therefore, in all such cases where a flattening of the grade of streets is necessary under the rule, the Building Line Platform is to be used, and the grade of the wider street as originally computed shall be reduced one-third, and that of the narrower street two-thirds, within the limits of the Building Line Platform. If the streets are of equal width the grade of the street traversing the shorter block length is to be reduced

one-third, and that of the street intersecting it two-thirds, within the above limits. This method of reducing the grade will result in a slight flattening across the intersection, and also change the original grade so as to provide a proper relation between the streets, based on their importance, if a further flattening is required to provide proper sidewalk slopes.

To illustrate the Building Line Treatment we will first take for example Intersection "B" on Plate 11.

Computing first the rate of grade in each direction from the intersection we inspect them and find that the rate in one street exceeds 3%, and therefore necessitates the use of the Building Line Platform. As the rate of grade in excess of 3% in this case occurs in two instances on the narrower street, we reduce these rates two-thirds and apply the resultant rate of grade for the distance from the Center Line Intersection to the boundary of the Building Line Platform, measured along the center line of this street. This determines the elevations of the center line of the narrower street at the boundaries of the Building Line Platform. The rate of grade on the wider street is in each instance less than 3%, and these grades are, therefore, not flattened, the elevation of the center line of this street at its intersection with the Building Line Platform being computed at their respective original grades. From these elevations at the boundaries of the said platform determine the elevations of the top of the curbs at points immediately opposite, allowance being made for the difference in elevation between the center line and the tops of the curbs previously described. From the elevation of the curbs producing the higher elevation at the building line corners apply a 2% transverse sidewalk slope if practicable, otherwise the minimum slope on the higher side and up to the maximum of 6% on the lower side. Opposite each of these corners on the lower side compute the resulting rate of grade. If it does not exceed the maximum of 6% the results are proved to be consistent with the rule. Whenever practicable it is proposed to grade the wider street with a longitudinal slope across the intersection but approximately level transversely. To obtain this latter condition the elevation at the intersection of the center line of the narrower street with the Curb Line Platform of the intersected street is made the same as that of a point on the center line of the intersected

PLATE 9.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.

FIG. 1.—NORTHEASTERLY CORNER OF THIRD STREET AND SEVENTH AVENUE, BROOKLYN. TRANSVERSE SIDEWALK SLOPE ON FORMER STREET REVERSED, CARRYING DRAINAGE TOWARDS THE BUILDING.

FIG. 2.—NORTHWESTERLY CORNER OF HOPKINSON AVENUE AND PARK PLACE, BROOKLYN. SHOWING SIDEWALKS STEPPED OFF OPPOSITE BUILDING, LEAVING ONLY ONE HALF OF ITS WIDTH AVAILABLE FOR PEDESTRIANS.

street immediately opposite the first named intersection. The elevations for the intersections of the curb tangents, for the building line and for the curbs within the limits of the Building Line Platform are derived as previously described under the Curb Line Treatment.

Attention is particularly called to the fact that in intersections similar to this only the grades of the portions of the street that exceed 3% are originally flattened.

In many cases no further flattening than the one just described is necessary, but when treating streets having steeper grades or meeting at a more acute angle a further adjustment is necessary which is provided for in Paragraph 5 (*b*).

For example, we assume conditions as represented by Intersection "A," Plate 12, of two streets, one 60 ft. and the other 80 ft. in width, intersecting at right angles, with grades in excess of 3% in each direction from the intersection.

Under the rule the grades of the wider street are to be reduced one-third and those of the narrower street two-thirds. From these new rates compute the elevation of each center line at its intersection with the Building Line Platform. It should be noted that in this case two of the street grades as originally computed are more than 6% and, therefore, under Paragraph 7 of the rule a maximum transverse sidewalk slope of 10% is permissible for this entire intersection. Instead of immediately proceeding to compute the elevations of the curbs and building lines considerable time will be saved by an inspection of the results already obtained to determine which corners will control the grades of the streets adjoining it. Thus it will be seen that the differences in elevation between the center lines opposite the upper right-hand and the lower left-hand building line corners are so slight that they will not provide an excessive transverse sidewalk slope at these corners. The differences between the elevations of the center lines opposite the upper left-hand and the lower right-hand building line corners, however, are so large as to indicate that even if the sidewalks are made level on the higher side that there will be a resulting slope across them on the lower side slightly less than the maximum opposite the former corner and slightly in excess of the maximum opposite the latter corner. Therefore, we first proceed to compute the elevations of the tops

of the curbs and the building line at the lower right-hand corner and we find that there is a difference in elevation between the building line corner and a point immediately opposite on the lower curb of 2.3 ft., or a resulting slope across the sidewalk of 13 per cent. According to the rule this must be reduced to 10% as prescribed in Paragraph 5 (*b*) by adjusting the elevations of the center lines opposite this corner so as to remove the excess in elevation over that required for the 10% sidewalk slope; the adjustment on each street being directly proportional to the rates of grade originally used to compute the elevations of the center lines at the boundaries of the Building Line Platform.

Thus, the original grade on the wider street of 4.8% reduced one-third became 3.2%; similarly, the rate on the narrower street was 9%, which, reduced two-thirds, became 3 per cent. The difference in elevation between points on the center lines opposite the building line corner based on these reduced grades is 2.2 ft., to which must be added 0.1 ft., the latter being the difference in elevation between the center line and the top of the curbs on the wider street, making a total of 2.3 ft. From this we deduct the equivalent of a 10% slope for the sidewalk width of 18 ft. or 1.8 ft., leaving an excess in elevation over that allowable of 0.5 ft., which is to be apportioned between the two streets directly proportional to their respective grades as originally flattened, and as follows: The grade of the wider street is to the sum of the grades as the amount of adjustment for the wider street is to the total amount to be apportioned, or 3.2% : 6.2% :: x : 0.5 ft. = 0.3 ft.; similarly for the narrower street, 3.0% : 6.2% :: y : 0.5 ft. = 0.2 ft.

These results indicate that a correction of 0.3 ft. and 0.2 ft. are to be applied to the elevations computed for the wider and narrower streets, respectively, it being added to the lower elevation and subtracted from the higher one. This last operation determines the elevation for the center line of the wider street of 39.3 ft., and 41.0 ft. for the narrower street. The curb on the wider street is to be 0.1 ft. lower than the center line or at an elevation of 39.2, and on the narrower street at the same elevation as the center line or 41.0 ft. Using a level sidewalk on the higher side opposite the latter elevation fixes the elevation of the building line corner at 41.0 ft. The resulting difference in elevation on the lower side is

41.0 minus 39.2 ft., or 1.8 ft., the equivalent of a 10% slope transversely across the sidewalk.

The successive steps required to complete the elevations at this intersection consist of deriving the elevations for the curbs and building lines at the remaining corners; fixing the elevations of the center line of the narrower street at its intersection with the Curb Line Platform the same as the elevation of the Center Line Intersection; determine the elevation of the intersection of the curb tangents from the elevation of the center line of the wider street, allowance being made for any correction due to the roadway width, and finally provide for resuming the 2% transverse sidewalk slope wherever it has been departed from. These results are all indicated on the plate of reference as are also the final grades within the limits of the intersection.

Intersections "A" and "B" on Plate 11 and Intersection "A" on Plate 12 illustrate completely the treatment to be given to practically all classes of intersections, the only exceptions being those intersections formed by streets of equal width. In these latter cases the street traversing the shorter block length is to be treated identically the same as the wider street and the street traversing the longer block the same as the narrower street, as hereinbefore described.

Slight variations in the above treatment may be necessary, consisting of a more extensive adjustment than that previously described, but along the same lines, as illustrated by Intersection "B" on Plate 12, representing two streets intersecting at an angle of 45 degrees.

The conditions opposite each acute-angled corner is somewhat different from the others previously cited. The grades of each portion of the narrower street exceed 3%, and they are therefore reduced two-thirds; but an inspection of the wider street shows that each of its grades are less than 3%, and they are therefore not flattened originally, the elevation of the center lines at their intersection with the Building Line Platform in the former case being computed from the reduced grades and in the latter case from the grades as originally calculated. When attempting to proceed further to remove the resulting sidewalk slope the mistake should not be made of reducing the grades of this wide street one-third, but the difference in elevation between the center lines opposite the

acute building line corners over the amount allowable under the rule should be treated as an excess to be removed proportional to the grades then existing along the center lines opposite the said corner. Otherwise the remaining operations are similar to those previously described.

The treatment to be given to that class of intersections formed by more than two streets deserves consideration on account of its complicated nature and as an illustration of the general procedure in these cases the lay-out represented by Plate 13 has been selected from the City Map as being typical of or perhaps somewhat more extreme than the average. A street system similar to this would probably not be adaptable to other than a comparatively level territory and no changes have been made in the elevations adopted excepting to interpret them as applying to the intersection of the center lines.

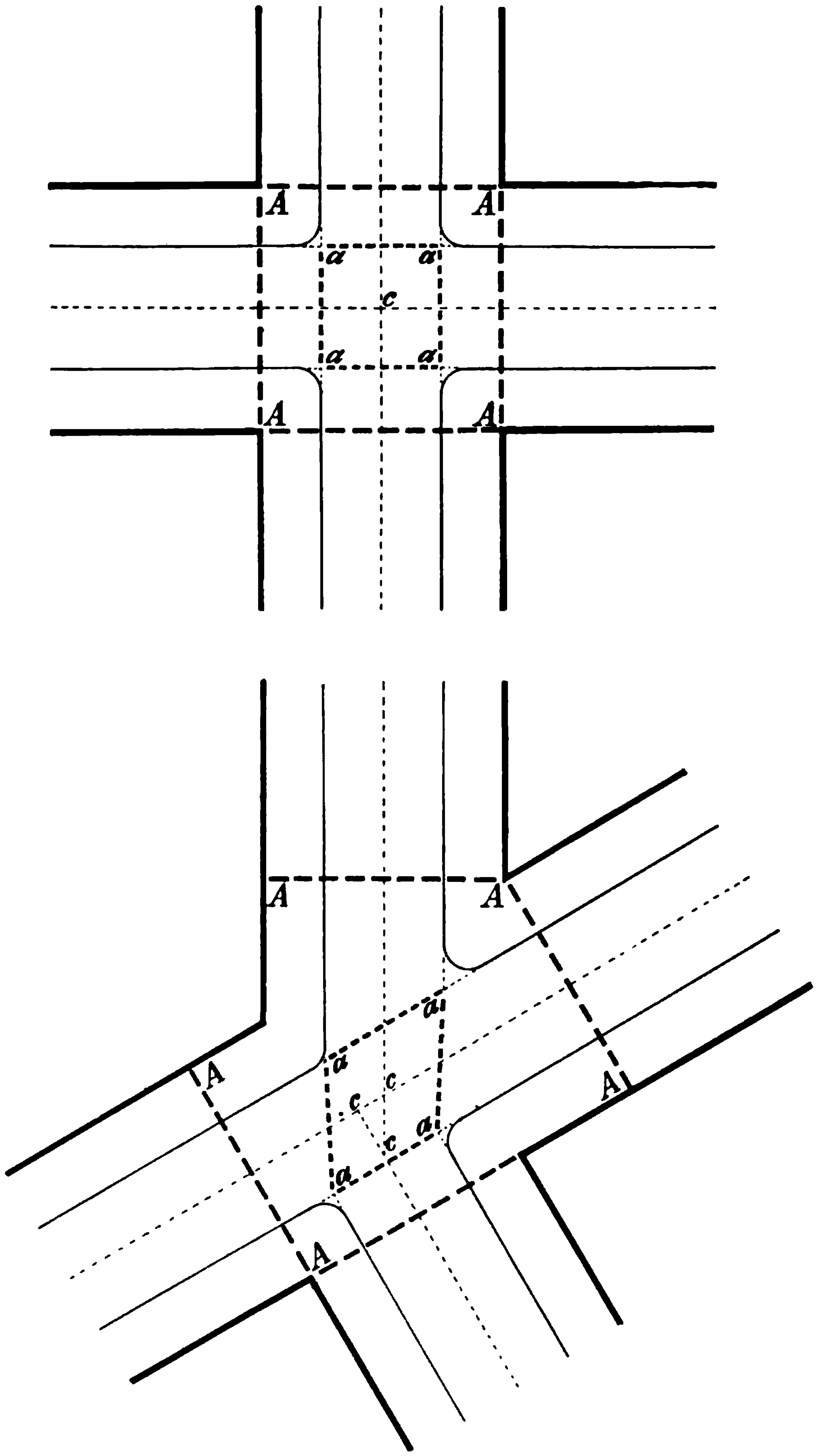
The rate of grade within the limits of and outwardly from the intersection having been computed, the next step consists of deciding whether this case represents a single intersection or more than one.

The question of what constitutes an intersection under the rule might here be properly raised. If two or more streets intersect a third street approximately opposite each other but at different angles, so as to form an open, irregular area, or what is commonly termed a Public Place, this condition is interpreted as being a common intersection comprising the area bounded by the street lines and by lines at right angles to the center lines and passing through the building line corners, giving the greatest platform area. Plate 13 illustrates such an intersection.

The value of a clear interpretation of this phase of the subject lies particularly in the fact that elevations fixed within the limits of the Building Line Platform are not to be flattened except as a final resort to remove an excessive transverse sidewalk slope as prescribed in Paragraph 5 (*b*).

The limits of the platform opposite the northerly corners of First Street at its intersections with Avenue A and Avenue B is easily determined, but an attempt to limit the platform by a line at right angles to a center line and passing through the westerly corner of Avenue A and Avenue B results in a platform not

PLATE 10.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.



Explanatory Note

Center Line Intersection indicated thus c, and c,c,c
Curb Line Platform " " a, a, a, a
Building Line Platform " " A,A,A,A

bounded by the respective lines of any one street; indicating that the area must be extended to secure this result. Obviously this condition is obtained by lines at right angles to the respective center lines and passing through the northwesterly corner of Second Street and Avenue A, the southeasterly corner of Second Street and Avenue A and the southeasterly corner of Avenue B and Second Street; which gives the greatest possible platform area.

Having demonstrated that the area within the lines of Avenue A and Avenue B from approximately the northerly line of First Street to the southerly line of Second Street comprises a single intersection, we find by inspection that the grade on the westerly portion of Second Street exceeds 3%, and therefore the entire platform is subject to the Building Line Treatment.

Considering first the southeasterly intersection of Second Street and Avenue B, it will be observed that southerly and easterly from the intersection of the center lines the originally computed grades are applied, producing results at the corner requiring no further adjustment. Similarly the grades northerly and westerly from the intersection require no flattening.

At the intersection of Second Street with Avenue A the treatment is practically the same except that the grade on the westerly portion of Second Street is reduced one-third. Attention is directed to the extent of this reduction, it being based on a comparison between two 60-ft. streets, the amount of the flattening being determined from the street traversing the shorter block, viz., from Avenue A to Avenue B.

The intersection adjoining the northeasterly corner of Avenue A and First Street requires a computation of the elevations of the center lines opposite the acute-angled corner at the grades originally calculated. The resulting difference opposite the building line corner between the elevations thus calculated is 2.9 ft., from which is deducted the equivalent of a 6% slope across the sidewalk of the wider street, leaving an excess to be removed of 1.8 ft., or an adjustment of 1.0 ft. on the wider street and 0.8 ft. on the narrower street.

At the intersection of Avenue B and First Street the conditions are somewhat different from those previously described. Here the elevations computed for the northerly building line corner

from the higher curb results in a 10% transverse sidewalk slope, whereas 6% in this case is the maximum. This excessive sidewalk slope is to be removed proportional to the original grades, which results in a flattening of the grade between elevations established within the limits of a Building Line Platform on First Street, and illustrates the only condition under which similar grades are to be flattened, *i. e.,* as a final resort to remove an excessive transverse sidewalk slope.

Along the center line of Avenue B, between Avenue A and First Street, the grade originally computed is 3.9%, which is subject to no reduction, due to its being within the limits of the Building Line Platform and for the same reason no flattening is to be made in the existing grades in each direction from the intersection of the center lines of Avenue A and Avenue B.

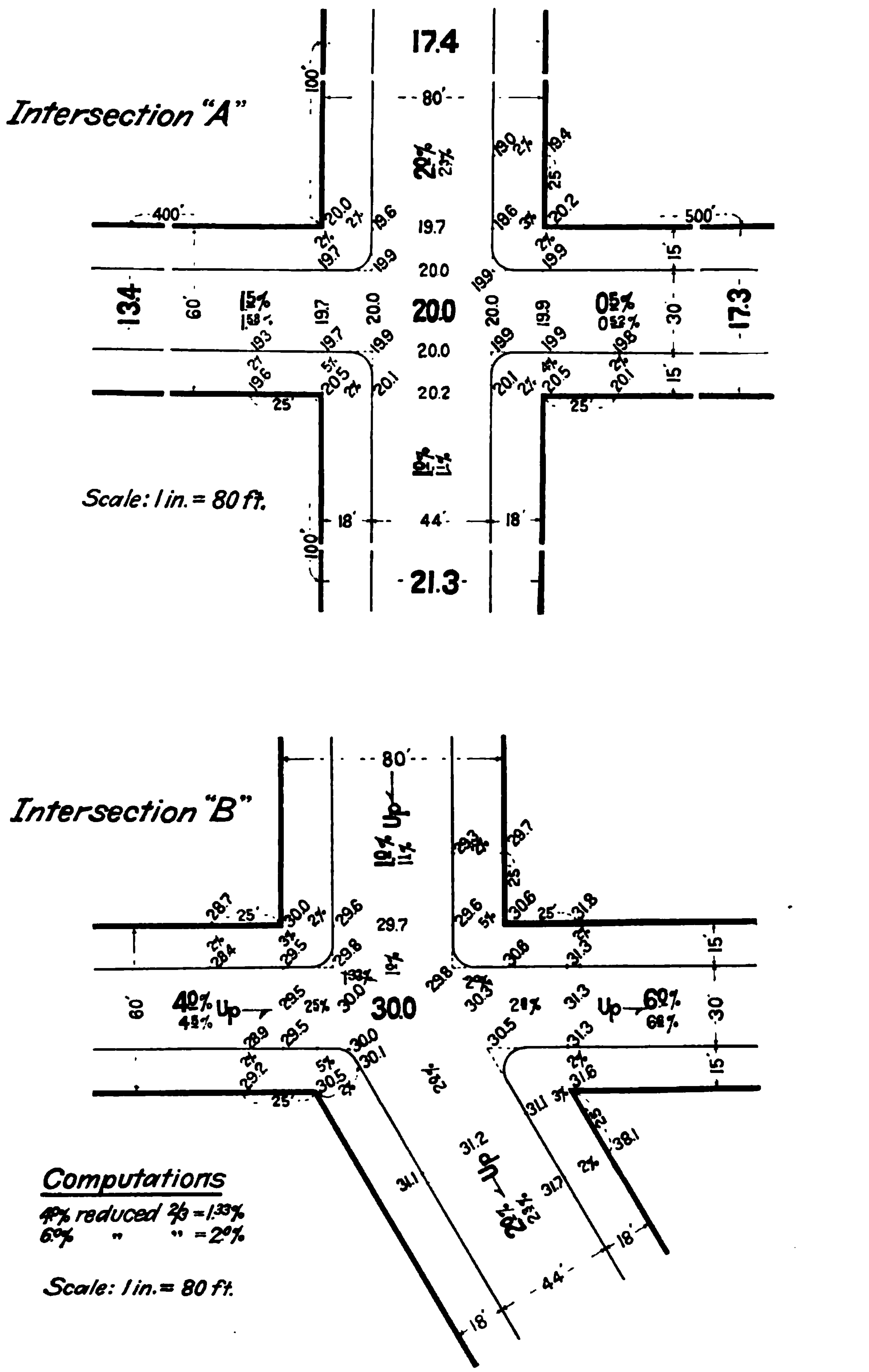
The operation of finding the remaining elevations is not here described in detail for the reason that the treatment is similar to that of the other intersections described, but all of these elevations are shown upon the plate referred to.

Doubtless some criticism will be made in regard to fixing elevations for points in the roadway of intersecting streets within the area that is of necessity a warped surface, but nearly all of these elevations are required for the purpose of calculating the elevations of the curbs and building lines. An inspection of numerous cases indicates generally that there will be no obstacle in the way of retaining them and at the same time securing proper drainage and a good appearance.

Adaptability.

It is believed that the proposed method will provide results agreeing very closely with the best average practice for the entire City and that few changes will be required in the present mapped elevations to make it applicable to all intersections. At the same time, it is not to be expected that any ordinance will prove to be a complete success unless some consideration is given to the provisions thereof when originally establishing the grades. This is especially necessary for complicated intersections, for streets that are designed to become important thoroughfares, requiring a uniform grade across the intersecting streets, and for streets having improvements thereon to which it is desired to conform.

PLATE 11.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.



Explanatory Note:

Established elevations and grades are indicated thus ----------- **30.0**

Elevations and grades interpreted under the proposed rule indicated thus -- 31.3

Whenever it is desired to provide special treatment for any street, sufficient elevations are to be indicated upon the map to control the principal features thereof, the remaining portions only being subject to the provisions of the rule. Similarly, streets that are improved prior to the adoption of any precise method of treatment will control the intersecting streets that are subsequently improved.

Inasmuch as the center lines have been made the basis of calculation for computing grades, it will be necessary to establish an elevation at their intersection.

In defining the platforms used, no difficulty has been experienced in referring them to some definite portion of the street lines, excepting in those intersections made up wholly or in part of curved streets, and in many of these cases it will be found advisable to indicate on the map the boundaries of the platforms to be used.

The proposed rule is appended.

PROPOSED ORDINANCE GOVERNING STREET GRADES.

1. *Definition of Platforms.*—The Center Line Intersection shall be deemed to be the point of intersection of the center lines, except for cases where the center lines do not meet at a common point, when it shall be the area included within the center lines at their intersection.

The Curb Line Platform shall be deemed to comprise the area included within the lines connecting the points of intersection of the curb tangents, or in the case of a street terminating at another street it shall comprise the area within the prolongations of the curb lines across the intersection and a line joining the curb tangents.

The Building Line Platform for rectangular intersections shall be deemed to include the area bounded by the prolongations of the building lines of both streets across the intersection so as to comprise the greatest platform area. In the case of other than right-angled intersections, it shall comprise the area bounded by the respective lines of each street and by lines at right angles or normal to the center lines and passing through acute-angled build-

ing line corners, or the corners giving the greatest platform area. If the intersection of the center lines falls without the Building Line Platform, as above described, the said platform shall be increased sufficiently to include the said intersection. When the building line corner is turned with a curve the platforms above defined shall be indicated upon the map unless herein definitely fixed.

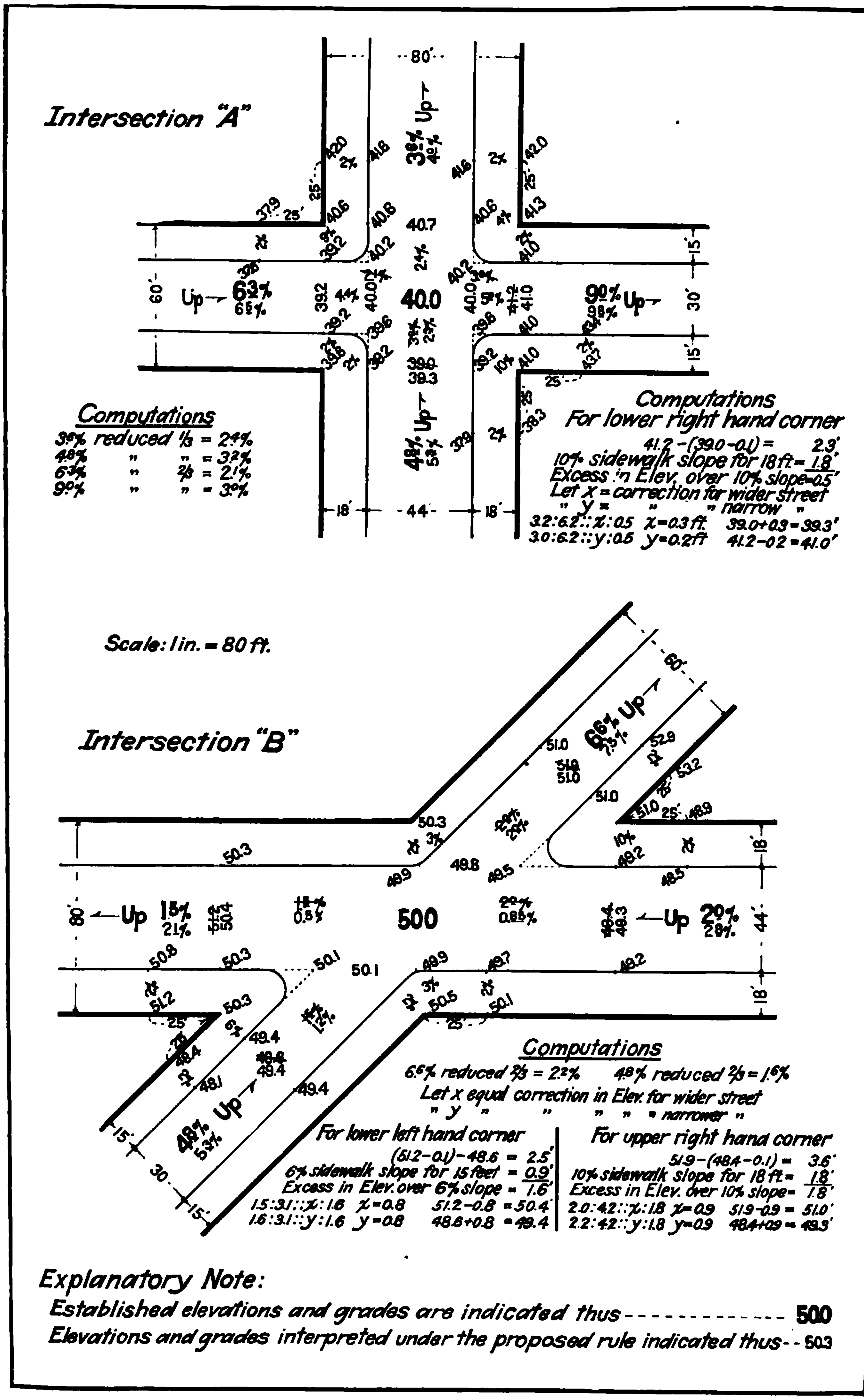
2. *Definitions of Elevations Fixing Grades.*—Unless otherwise indicated on the map, the elevations shown at a street intersection shall be deemed to be that fixed for the point of intersection of the center lines of both streets affected, or for the Center Line Intersection.

3. *Treatment of Center Line Intersection.*—The Center Line Intersection, when it comprises an appreciable area and unless otherwise shown on the map, shall have a uniform elevation at its boundaries, and in determining the elevations for the other platforms herein described, the Center Line Intersection referred to as a basis of calculation shall be deemed to be the nearest point on the center line of each street at the boundary of the said platform.

CURB LINE TREATMENT.

4. *Treatment of Platform for Streets Having a Light Grade.*—If the grade of each of the intersecting streets is 3% or less, as determined by calculating the rate between the established elevations, the elevation of the center lines of each street within the limits of the Curb Line Platform shall be the same as that fixed for the Center Line Intersection. The elevation of the curbs shall be determined as indicated in Paragraph 8. Provided, however, that the difference in the elevation of points on the center lines opposite any building line corner, shall not provide a greater transverse sidewalk slope than that fixed as the maximum in Paragraph 7, in which latter event the Building Line Platform shall be used and the grades of that portion of the streets adjoining the said corners shall be flattened between the boundaries of the Building Line Platform and the Center Line Intersection, as provided in Paragraph 5 (a).

PLATE 12.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.



Building Line Treatment.

5. *Treatment of Platform for Streets Having a Steep Grade or Meeting at an Acute-angled Intersection.*—

(a) If the grade of any portion or portions of intersecting streets adjoining a building line corner is over 3%, as calculated between the established elevations, or if a further flattening of the platform grade is required to provide proper sidewalk slopes, for any part of an intersection described in Paragraph 4, the grades of the said portion or portions of each street shall be reduced between the boundaries of the Building Line Platform and the Center Line Intersection as follows: If the intersecting streets are of the same width, the grade of the street traversing the shorter block length adjoining the intersection shall be reduced one-third and that of the street traversing the longer block shall be reduced two-thirds. In case the streets have different widths, the grade of the wider street shall be reduced one-third and that of the narrower street two-thirds between the above limits. All grades less than 3% which are not herein required to be flattened shall be applied at the same rate as originally computed between established elevations. Provided, that in no case shall the maximum platform and sidewalk slopes fixed in Paragraphs 6 and 7 be exceeded.

Any excess in grade over that allowed in Paragraph 7 shall be removed by further flattening, as follows:

(b) Special flattening of platform grades for extreme cases of steep grades or acute-angled intersections.—If the difference in elevation tentatively fixed for points on the center lines of intersecting streets opposite any building line corner, after applying the minimum and up to the maximum transverse sidewalk slope on the higher and lower sides respectively, exceeds the maximum transverse sidewalk grades hereinbefore described, the elevation of each street at the boundary of the Building Line Platform shall be adjusted to remove the excess, the adjustment of each of the said elevations being directly proportional to the grade of each as originally flattened or applied.

For all cases covered by Paragraphs (a) and (b) the elevations at the intersections of the center line of each of the narrower streets or at the streets traversing the longer blocks, if they are of equal width, with the Curb Line Platform of the intersected street

shall be the same as the elevation of a point on the center line of the intersected street immediately opposite the first named intersection, except that the elevation at this point shall be abandoned when the grade along the center line between the Curb Line Platform and the Building Line Platform exceeds the grade as originally computed.

The grades of the center line of the wider street or of the street traversing the shorter block, if they are of equal width, shall be uniform between the exterior boundaries of the Building Line Platform and the Center Line Intersection, except that the maximum platform slope hereinafter fixed shall not be exceeded. The grades of the center line of the narrower street or of the street traversing the longer block, if they are of equal width, shall be uniform between the elevations fixed at the exterior boundaries of the Building Line Platform and those fixed at the boundaries of the Curb Line Platform, and also between the latter point and the Center Line Intersection.

6. *Maximum Platform Grades.*—The maximum allowable grade along the center line between the Curb Line Platform and the Center Line Intersection shall be at the rate of 4 %, unless otherwise indicated on the map.

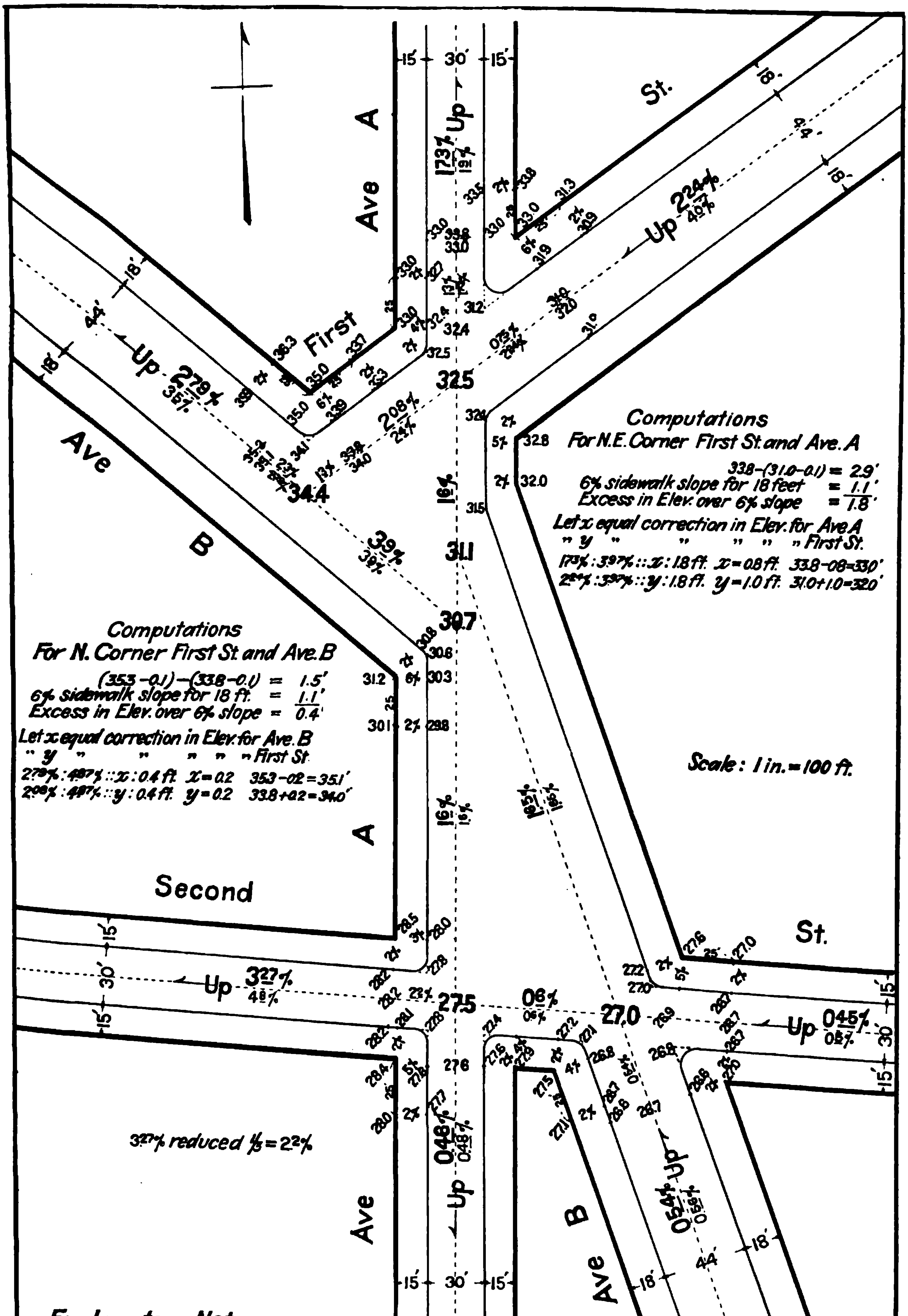
The grades along the center line between elevations established within the limits of a Building Line Platform shall be uniform, subject only to the flattening provided for in Paragraph 5 [illegible].

7. *Transverse Sidewalk Grades.*—Whenever practicable, the sidewalk shall slope upwards in a direction at right angles to the curb toward the building line at the rate of 2 per cent.

The elevation of the sidewalk at the building line corner shall be determined by applying this rate to the elevation of the curb, giving the lower building line elevation at a point immediately opposite the corner, unless the resulting grade on the lower side exceeds 6 %, in which case the sidewalk shall be level on the higher side and a greater transverse sidewalk slope up to the maximum shall be used on the lower side.

The maximum transverse sidewalk slope shall be 6 %, except in those cases where the street grade as originally computed on any street adjoining a building line corner is more than 6 %, when

PLATE 13.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
MOON ON PROPOSED METHOD OF
INTERPRETING STREET ELEVATIONS.



Explanatory Note:

Established elevations and grades are indicated thus - - - - - - - - - - - - - - **32.5**

Elevations and grades interpreted under the proposed rule indicated thus - - - 27.0

the maximum slope shall be 10% for either street, opposite the said corner. In no case shall the sidewalk at the building line be lower than that of a point immediately opposite it on the curb.

If the transverse sidewalk slope at the building line corner is more or less than 2%, it shall be made to agree with this latter rate at a point distant 25 ft. from the building line corner.

8. *Curb Elevations.*—The relation between the elevation of the center lines and of the top of the curbs at points immediately opposite it at the boundary of and outwardly from the Building Line Platform shall be as follows: For roadway widths of 24 ft. or less the top of the curbs shall be 0.1 ft. higher than the center line. For roadway widths ranging from 24 ft. up to and including 34 ft. the top of the curbs and the center line shall be at the same elevation. For roadway widths ranging from 34 ft. up to and including 44 ft. the top of the curbs shall be 0.1 ft. lower than the center line. For roadway widths ranging from 44 ft. up to and including 54 ft. the top of the curbs shall be 0.2 ft. lower than the center line, and for roadway widths ranging from 54 ft. up to and including 64 ft. the top of the curbs shall be 0.3 ft. lower than the center line.

The elevation of the intersection of the curb tangents shall be determined from a point immediately opposite on the center line of the wider street or the street traversing the shorter block, if they are of equal width, subject, however, to the same correction in elevation between the top of the curbs and the center line as herein provided.

9. *Depth of Gutters.*—Whenever practicable a standard depth of gutter of 0.4 ft. shall be used.

10. *Curb Grades at Corners.*—The tangents in the curbs shall be graded uniformly between the elevations established for them at the boundaries of the Building Line Platform and at the intersection of the curb tangents. The curve formed in the curb joining the tangents shall follow a uniform grade between the elevations of the curb tangents at the points of curve.

11. *Grades Between Platforms.*—The grades of the center line and of the curbs between the elevations computed at platform intersections, or between a platform and an intermediate established elevation, shall be uniform.

DISCUSSION.

Henry W. Vogel, M. M. E. N. Y.—Mr. Moon has agitated a question which has troubled the minds of many surveyors in working from a few figures on filed maps to conditions in detail on the ground. There are present, to-night, gentlemen who have made roads and roadways a study. I will call on Mr. Schaeffer of the Bronx.

Amos L. Schaeffer, M. M. E. N. Y.—I did not hear the rule read. I came in late—but I heard a good many of the exceptions. I am not sure that the old rule that "the exception proves the rule" applies here, because the rule seems to have gotten lost in the great number of exceptions. I think we all realize that some method should be employed for fixing grades at points where intersecting streets have heavy gradients which will give better results than those which are now employed. The method of establishing platform grades for the area lying between the intersection of the curb corners or even the single grade point at the intersection of the centre lines of streets gives good results where the gradients of the streets are light. The discussion therefore applies more particularly to those parts of the City where the surface of the ground is undulating. These conditions prevail in the upper portion of Manhattan, in the Bronx and in Richmond. I believe that the present methods are fairly satisfactory to Brooklyn and Queens, where the surface of the ground is comparatively flat.

The only objection to the method, in my opinion, is that it is too complicated. I have taken up on several occasions the annual report of the Chief Engineer of the Board of Estimate for 1908, in which is contained a discussion and diagrams of this method of fixing grades, for the purpose of getting an understanding of the subject, but found it exceedingly difficult to follow. The discussion of the paper by the author this evening has made the method much clearer to me than it has ever been before. I am still of the opinion, however, that it is too complicated to be of use generally by parties in the field for calculating grades for immediate use. To be of practical value, all the grades must be calculated in the office and shown on a map, so that they can be readily taken off for use in the field. No information but the grades of streets should be shown on these maps.

If all field parties were required to calculate the grades on the ground, frequent errors would undoubtedly occur. I also doubt if city surveyors would feel that they had the time to go through these elaborate calculations. The work should be done by men in the office, whose special duty it should be to calculate all the eleva-

tions required at each intersection or at intermediate points. These men would soon become expert and the danger of error would be removed.

I am in full sympathy with the method, but, as before outlined, all of the work of fixing the elevations must be done in the office and shown on a grade map, so that the field parties can take from the map all the elevations and their locations. I think it would be very interesting if a model could be prepared, showing all the different planes which would result from this method at a complicated intersection.

VERNON S. MOON, M. M. E. N. Y.—The problem of formulating a method for definitely interpreting the elevations of the street surface from the established grades is far from being a simple one, but, when in addition thereto, it becomes necessary to make provisions that will enable the various Borough Engineers to carry out their individual ideas, then it is not surprising that the rule contains some exceptions. These exceptions seem to appear quite conspicuous to Mr. Schaeffer, but this is doubtless due largely to the fact that they have been repeated in explaining the procedure for deriving the elevations for each of the intersections described.

As previously stated, the method now presented has been simplified considerably over that originally published, and while it may not be possible for a person who is unfamiliar with it to immediately apply it, still I believe that after a little study it will be readily understood and its application at any future time will be comparatively easy.

As pointed out by Mr. Schaeffer, these elevations would naturally be computed once and for all in the office and placed on a map, which would be available for the use of all Departments requiring them. It seems to me that this work should be done when the grade map is originally prepared, as a part of the study of the conditions to be created by the proposed elevations.

If any method for determining elevations were adopted, I have no doubt the City surveyors would readily apply it; in fact, I understand that even the method published in 1908 has been used by one of them for the past two years for computing the elevations shown on maps adopted as part of the City Plan. Advice has also been received that in another instance it has been adopted, practically as a whole, for an entire city.

In regard to models to show what results would be obtained by the proposed method, I believe that it will be found that the dimensions in the vertical plane are so small when compared to those in the horizontal plane, that they will hardly show when reproduced on a small scale. To make a model that would show the slopes, depths of gutters, etc., would require considerable distor-

tion vertically, thus indicating a much more extreme treatment than would actually exist on the ground. From a practical view-point, the elevations shown on the sketches herewith are almost identically the same as those supplied to the field engineers in some of the Boroughs for grading streets, and by a simple inspection of these elevations it is possible to tell whether they will provide good results.

George W. Tuttle, M. M. E. N. Y.—The writer of the paper has evidently given a great deal of study to the problem of making grades defined by elevations at intersections determinate while at the same time practicable.

It is plain that street plans should indicate the grades as definitely as the house lines, and if only elevations at center line intersections are shown, a method of interpretation is necessary.

Many different rules might be proposed which would be satisfactory, where grades are light and the street plan rectangular. It is only when we come to steep and acute intersections that serious difficulties arise. The simplest rule is that in which the "building line platform" is always made level regardless of topography, resulting in streets unnecessarily steep and uneven in appearance. The somewhat complicated rules proposed by the author of the paper appear to fit conditions much better.

It is not a particularly simple matter in many cases to determine from the center elevation the elevations at the building line platform, according to the method laid down in the paper before us. It should not be necessary to study rules and make computations every time these essential elevations are needed. The "building line platform" elevations are really the important elevations, since the grade throughout the block depends directly upon them, and they should always be placed on the map whenever the grade changes at said platform boundary, or whenever they cannot be readily determined by proportion from other elevations.

The method of the author of the paper, I think, attaches entirely too much importance to elevations at the intersection of center lines and along the center line of the street. The important grades, which when once fixed should stay fixed, are those at the house line, or, what is substantially equivalent, the curb line. These grades, of most importance and permanence, should be the ones given. There seems to be no good reason why the center line and center line intersection grades should not vary in their relation to the curb and house line grades, which we assume are fixed, as the type of pavement, grade and width of street may require.

The permissible transverse slopes in sidewalk and street at intersections, on which the elevations so largely depend, I believe have been well chosen. The statement of these limits should be useful to all engaged in grading streets.

This system of grade determination is primarily for new work, where the center elevations are given. In establishing these center elevations little difficulty arises where the country is flat, but where grades are steep and intersections acute, one would be rash to establish center elevations without considering the effect of the platform on the intermediate grade. Take the case of the 60 ft. street shown on page 103, Report of the Chief Engineer of the Board of Estimate and Apportionment, 1908. The grade is elevated at the upper end of the block on account of the platform by more than 7 ft., and lowered at the lower end of the block by more than 5 ft., from the straight grade connecting centers. The grade line, therefore, as determined from the rules, has little relation to the grade line drawn from center to center. This is a case which is not rare in some of the territory within the limits of the City of New York, and it makes clear that, when it is desired to hold a definite grade line, the relative elevation of center to building line platform has to be found before fixing the center elevation.

I believe it would be desirable and practicable to adopt a standard method of designating grades at intersections and elsewhere, using a reasonable number of elevations by which the grades would be completely expressed, and from which the elevation at any point could be found by proportion between those given.

If, with the above, the designer has before him diagrams of a few typical intersections worked out from observation and practice in the field to best meet conditions of traffic, drainage and appearance, and holds to definite limits for the direct, transverse and maximum slopes of sidewalk and roadway at intersections, determined by convenience and safety, it is quite likely that intersections would be graded to better advantage, and that the grades would be more conveniently expressed, than by following inflexible rules, more or less arbitrary, which are independent of local conditions.

Vernon S. Moon, M. M. E. N. Y.—Mr. Tuttle seems to feel that too much importance is given to establishing elevations along the center line, but he appears to have overlooked the fact that the rule is so worded as to allow each borough to show all the elevations it may see fit on their maps and to rely only upon the proposed method of interpretation when it provides results that conform to their individual ideas. Therefore, the amount of importance to be given to establishing elevations on the center lines, or anywhere else, lies entirely in the hands of the engineer in charge in each borough. The practice of showing all of the surface elevations on filed maps is generally admitted to be confusing, and the object of the presentation of this paper is to demonstrate that by the proposed method elevations established on the center lines only, can be definitely interpreted by any engineer, and that the results

thus obtained will agree very closely with the best average practice, except in those few extreme cases that are admitted to be entirely exceptional.

The criticism to the effect that in some cases there is a considerable difference between the grade line as originally computed between established elevations and the final grade as interpreted by the proposed method is equally true of the conditions now existing in more than one of the boroughs, except that in these boroughs there is absolutely no method of interpretation in use. It therefore appears that this problem must be considered as one relating to the entire City rather than to any one borough. The only apparent reason for desiring to hold to an exact rate of grade within the block is to conform with existing improvements, and, as previously stated, it is expected that these elevations will be shown on the map when establishing the grades.

In determining elevations at any intersection, the limiting forms of treatment, irrespective of local conditions, consists either of a level platform or in carrying the grades of each street unflattened across the intersection. Even with steep grades there is not a wide permissible margin between these two forms, and the rule now proposed provides what is believed to be the best average treatment lying between these two extremes. This average treatment has been arrived at by a careful study of the different ways in which similar intersections have been improved in the various boroughs.

An examination of the plates published with this paper and a trial of the method now presented, will, I believe, be convincing that the elevations shown furnish a basis for improving streets so that they will be properly drained and have a good appearance.

H. D. APPLEBY.*—I have listened with pleasure to the discussion. Like Mr. Schaeffer, I had a better insight into the problem from Mr. Moon's explanation than I had previously obtained by trying to decipher Mr. Tuttle's method in the report of 1908. I am inclined to think the proposed method is somewhat complicated, but it is a complicated problem.

I do not think that I am in a position to thoroughly discuss it as yet, because I would like to study it further. I am rather pleased, though, with the scheme as a whole. I think Mr. Tuttle and Mr. Moon are working along right lines. Whether that method should be employed or not I cannot say, but it is a well-worked-out method that can be used, and it does furnish a basis for discussion. On the whole I am pleased with it.

EDWIN H. THOMES, M. M. E. N. Y.—I would like to take up this question from a highway engineering standpoint. As I under-

* Assistant Engineer, Borough President's Office, Manhattan.

stand the scheme, the gutter line is to be a fixed standard gutter line and the crown will vary by even tenths of a foot. I think the method as a whole fixes the curb grades and the sidewalk grades very well for practically all conditions. It is the best and most definite method which I have seen, but it can be improved somewhat by a few slight modifications to better meet practical drainage and construction conditions. The most important thing is to establish the curb grades to give proper drainage. The curbs are usually constructed first and then the sidewalk and roadway grades are laid out from the curb lines. The gutter line should be at a uniform depth of about five inches below the top of the curb, except at receiving basins or other special places. The location and construction of basins should be standardized. Breaks in curb lines and grades should be eased off by horizontal and vertical curves of specified radii. It is better to fix the transverse slope of the roadway and the crown by a definite relation to the distance from the gutter line. This would increase the elevation of the center line intersection above that of the center line at the curb line platform, since the diagonal distance is greater. The center line intersection should be raised a little to give equal drainage where it is most required. In case of unequal elevation of opposite curbs, the crown would be automatically shifted toward the higher side, with uniform slopes to both gutters. Unless there are railway tracks or other permanent surface appurtenances in the street, the crown of the roadway may vary a little with the different classes of pavement. If the depth of gutter and the curb and sidewalk grades are established, the roadway surface may be easily changed during repaving without much difficulty. For these reasons the grades on the map should apply to the curb grades instead of the center line elevations.

The engineers of practically all the departments have occasion at different times to use the street surface grades, and they all ought to endeavor to have all the necessary information put upon the maps. I know that the topographical engineers will say that this entails a great deal of work and they have not the time and money available to do it, and that it will delay the final map, but some provision should be made whereby this may be done, otherwise it means that each engineer who wishes the information must duplicate all this work. The men who prepare the maps must necessarily perform a large part of this work anyway, and it would not be much additional labor for these trained office men to complete the work and place all the desired information upon the maps. The grade maps might be used as they are at present by adding a note that, unless otherwise noted, the elevations in the intersections apply to the curb grades. Skew intersections and

other special cases might be drawn to a larger scale upon the margin of the map and be properly referenced.

It is my opinion that the Board of Estimate should prescribe the minimum, maximum and standard longitudinal and transverse slopes of sidewalks and roadways and should then require that all changes of curb and sidewalk grades be definitely placed upon the maps, and that the governing points only of the roadway at skew intersections should be shown; then the problem would be nearly solved for all.

About two years ago the Board of Estimate established uniform roadway widths and radii of street curb corners for the whole City, and these other matters should be standardized and adopted as soon as possible.

SAMUEL C. THOMPSON, M. M. E. N. Y.—I have been very much pleased with the ingenuity with which the scheme has been worked out, although I am not in accord with a great many of the ideas advanced, and one of the first objections would be the establishment of grades on the center line of the street. I think it is a mistake to do that. It has been our experience in the Bronx that better results are obtained by using the curb as the place where the grade should be established, either at the house line or at the curb line, and varying the crown of the cross-section as necessary.

The objection to using the center line upon which to establish the grade is, in the Bronx practice, a serious one, viz.: In grading a street, the gutters are made 8 in. in depth, and the crown is materially above the grade that is established for pavement, where the gutters are made 6 in. only, so that using the center line would involve a change in the physical relations between the center and curb grades, or an equally objectionable addition or subtraction from the grade as filed, and introduce an increased possibility of error.

The paper as submitted by the author gets away with one proposition which has bothered me a good deal in the past, and I would like to get over it as easily as he does, and that is the ordinance of the City of New York, which says the rise of the sidewalk shall be 2 in. in 10 ft. In his remarks he seems to ignore that. Unfortunately, we have to pay some attention to this, or try to, in most of the work. If we could ignore it, the rest would be much easier.

In the illustrations which have been given by the author, which seem to develop very satisfactorily, the writer does not recall the working out of a case such as was illustrated by photograph at the junction of Anderson and Marcher Avenues, in the Bronx. The sharp angle of intersection of the two streets, and the pronounced gradients in the same direction (viz., downward), make an

extremely difficult situation to treat properly, for the raising of one portion of the intersection or the lowering of another would increase the straight gradients to such an extent as to render them practically prohibitive. That this condition might have been better arranged in the original establishment of the grades is unquestioned. but the conditions which confront the construction engineer, in a case of this kind, are not what might have been, but what are.

If the grade filings are made on steep grades, at the house lines, and the intersections made flat or practically so, a satisfactory solution of the problem is ordinarily not difficult. The intersection of curbs on slight grades can be taken as the limit of the grade platforms, and a satisfactory solution made.

VERNON S. MOON, M. M. E. N. Y.—If it can be shown that practically the same results are obtained by establishing center line elevations and using the proposed method of interpretation, as when the elevations of the various portions of the street surface are originally shown on the map, I can see no objection to the former practice.

The method of procedure for improving the street surface could be as follows: First: Compute the elevations for all parts of the street surface; Second: Set the curb and flag at the elevations derived for them and shape the roadway by eye between the curbs, the amount of crown used being dependent upon the character of the soil; Finally, when the pavment is about to be laid, stake out the elevations computed for the roadway. This procedure will obviate the necessity for making any deductions on account of the difference in crown between the earth roadway and the final pavement. An examination of the graded streets in each borough would seem to indicate that in general the earth roadways do not remain shaped long enough to justify determining elevations for crowning them.

Reference was made in the first part of this paper to the fact that there is an Aldermanic ordinance for some of the boroughs providing for a standard transverse sidewalk slope, and it was pointed out that it is impracticable to adhere to it at street intersections, except under very favorable circumstances. No serious consideration has been given to its existence, however, for the reason that it could be repealed if provision were made for substituting a better method. Attention is called to the fact that there has been no ordinance of this character in effect for the Borough of the Bronx since 1906, at which time the Aldermanic ordinances were recodified and, through an oversight, no provision was made for that borough.

The intersection referred to at Anderson and Marcher Avenues, in the Bronx, consists of approximately a 10% slope descend-

ing around a corner where the angle of intersection is about 30°. These streets have been graded in accordance with the mapped elevations, thereby creating a difference in elevation between the curbs opposite the building line corners of at least 7 ft.

The conditions opposite the upper right-hand corner, on Plate 12, Intersection "B," illustrates the treatment which, under the proposed rule, would be given to this class of intersections, *i. e.*, a reduction of the longitudinal street grades sufficient to provide a 10% transverse sidewalk slope on the lower side opposite the building line corner. Inasmuch as this procedure increases the grade considerably within the block, it is debatable whether this form of treatment would be more desirable than the existing condition. As pointed out by Mr. Thompson, such extreme cases as the one in question should be carefully studied and arranged for when originally establishing the grades.

H. L. Oestreich, M. M. E. N. Y.—I would suggest that the author could avoid the trouble of memorizing the figures for the different heights of crown, by assuming one one-hundredth of the width of the roadway to be the crown and the middle ordinate of a circular curve joining the gutters. He could still retain his 0.4 ft. gutter, which would be satisfactory for an asphalt roadway. This method would be simpler, especially where the curbs were not at the same elevation.

Edward M. Law, Jr., M. M. E. N. Y.—In the case of steep grades at acute intersections, provision can be made for a transverse slope across the roadway at the building line platform corners, which will fit the ground better, and reduce the sidewalk slope on the lower side of the acute intersection.

This transverse slope across the roadway may be made as high as 4% in extreme cases, in place of holding the roadway level across, as shown in the diagrams of the proposed ordinance. In many cases this treatment will permit carrying the curb straight through the block between curb intersections, thus doing away with the break in the curb and sidewalk at the building line corner.

Vernon S. Moon, M. M. E. N. Y.—The practice of using a transverse slope from curb to curb may be found advantageous in some instances, but I regard it as special treatment which should be taken care of by showing all the necessary elevations on the map. In carrying out this treatment it is customary to shift the crown toward the higher curb, with the result that an excessive slope is introduced across the roadway on the lower side, as shown in Plate 7, Fig. 2. It is claimed as an advantage that this method fits the ground better, necessitates no break in the curb grade and in effect keeps the grade lower within the block.

The advisability of using a transverse slope across the roadway of streets having a width in excess of 60 ft. is questionable, for the reason that in all probability these streets will at some time be equipped with car tracks requiring each pair of rails to be at approximately the same elevation. For streets having a width of 60 ft. or less the difference in elevation when using the maximum slope of 4% across the roadway is about 1 ft., which is the measure of the cut or fill which is saved by this method of fitting the natural surface. By not resorting to a flattening of the grade this one foot aids in keeping the grade lower within the block, but if applied to the usual minimum length block of 200 ft. it would only affect the grade one-half of 1 per cent. In my opinion the amount gained by this method does not generally justify the resulting distortion of the roadway.

The alternative treatment, as proposed in the rule, provides for a flattening of the curb within the limits of the intersection, when necessary, and keeps the curb at the same elevation at the boundary of the building line platform. The resulting break in the curb grade does not appear objectionable, if the curb is carefully set and the increase in grade within the block directly due to abandoning the transverse slope across the curbs is inappreciable.

ARTHUR S. TUTTLE, M. M. E. N. Y.—The City of New York expends annually nearly a million dollars on the City map. Block dimensions and angles are determined with the utmost precision, and the maps purport to give street grades with similar refinement. Engineers familiar with street work are well aware of the fact that while no question is left as to the position of the street lines, in so far as the vertical bounding planes are concerned, the methods used for fixing the elevation of the surface are exceedingly unsatisfactory, owing to the wide latitude offered for variety of interpretation. The failure of various branches of the City government and of surveyors employed by property owners, to agree among themselves as to just how the grades shown on the City map are to be applied to any particular improvement, is clearly evidenced by the photographs which the author has presented.

Believing that this confusion was unfair to all interests, and that its existence could not be justified, an attempt was made in 1908 to formulate a method which would remove any uncertainty as to how street grades should be interpreted. Suggestions have heretofore been made by various engineers having in view the solution of this problem, but so far as known these were limited to the space within the roadway limits. The proposition formulated in 1908 was made to include the entire street area so that buildings could be erected in advance of a grading improvement with definite assurance as to the grade proposed at the building line. It was thor-

oughly tested as to practicability by applying it to every variety of intersection and slope. The criticism which has been offered concerning the complexity of the rules then suggested is unquestionably a fair one, and the only answer that can be made to it is that the problem is not a simple one and cannot be solved by rule-of-thumb methods. Mr. Moon has succeeded in removing some of the objections on this score, but in general the proposition follows the same lines. His thorough and clear explanation of the points involved will, I trust, aid in removing the objections which have heretofore been raised.

HENRY W. VOGEL, M. M. E. N. Y.—The question has often been asked me how the grade elevations given on filed maps could be interpreted in a uniform way by surveyors. My response has been that the final maps filed in offices of record do not give sufficient information. The grade elevations on the house or building line at every corner, angle point, point of curve and point of change in gradient should be shown on the final maps showing the plan of streets, block dimensions and location of monuments.

The grade elevations on the curb lines must necessarily be calculated before the location of receiving basins can be determined, it would therefore require no extra calculation to show the grade elevations on the curb lines at every corner, angle point, point of curve and point of change in gradient on the filed maps showing plans for drainage or sewerage.

If the maps heretofore filed are on too small a scale to show the grade elevations suggested, the scale of the maps should be enlarged in the future.

I believe Mr. Moon's rules are very good. If they are not the best he will be glad to receive suggestions for improvement. Then when we have the best rules, let the Borough President's engineers determine the grade elevations suggested, and indicate them on the building lines on the final maps showing the street plan, and on the curb lines on the maps showing the plan for drainage or sewerage.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 64.

PRESENTED APRIL 26TH, 1911.

SANITARY PROBLEMS OF THE BOARD OF WATER SUPPLY.

BY ANDREW J. PROVOST, JR.,* M. M. E. N. Y.

WITH DISCUSSION BY

HENRY W. VOGEL, HERBERT D. PEASE, DAVID S. FLYNN, ROBERT RIDGWAY, CHARLES E. WELLS, FRANK E. WINSOR, AND ALFRED D. FLINN.

The work of the Board of Water Supply in furnishing the City of New York with a large additional supply of water from the Esopus watershed in the Catskill Mountains is well known to this Society through valuable technical papers heretofore presented and discussed.

Briefly stated, the work consists of the erection of a large dam for impounding the supply, the construction of about 90 miles of aqueduct, and a large distributing or equalizing reservoir on high land in Westchester County. Contracts for all this work are under way and the total force employed probably amounts on the average to between 15 000 and 20 000 men. The total number of persons connected in one way and another with the work approximates 25 000.

The principal sanitary problems relate to housing these people and regulating their modes of life by precautions not heretofore fully observed on similar works.

Comparatively few of the workmen are drawn from the territory through which the work passes, the greater part being of foreign

* Sanitary Expert, Board of Water Supply.

nationality, of the migratory type now common in this section of the country, Italians, Slavs, Poles and Negroes. There is also scattered along the line of the work a considerable number of Negroes, who are employed chiefly on account of previous experience in, and their adaptability for, rock blasting and tunnel work.

These classes of labor are accustomed to shift for themselves. being contented with, and apparently preferring, inadequate shelter and food. The necessity for cleanliness has no place in their intelligence, and if left to themselves their abodes and methods of conduct are exceedingly primitive and in violation of the entire sanitary decalogue.

Toward the beginning of the Board of Water Supply work it became evident that important reasons existed why sanitary regulation of the labor force must receive greater attention than it had heretofore received in this country. In the first place, the communities through which the work passed required protection against infection by contagious and communicable diseases. Second, the operations of the work being within or adjacent to numerous sheds contributing surface water for public and private potable water supplies, the reasonable protection of these supplies against pollution was imperative. Finally, in order that the work might proceed effectively and without unnecessary interruption, and for humanitarian reasons, it was essential that the health of the force be maintained and all possible preventable disease eliminated.

It became evident also that regulations for sanitary control must be somewhat flexible in order to satisfy the more or less exacting requirements based upon the location of the work and the housings of the workmen. There are, however, certain precautions common to all encampments, independent of their size or their location, with respect to communities or watersheds. These relate to the maintenance of the health conditions in the camp itself, and include the following principal precautions:

Site.—This must be on dry or properly drained soil, substantially free from trees and remote from ponds, pools, swamps or other collections of water capable of propagating malarial mosquitoes. Italian laborers, very frequently on account of previous infections, possess the power of transmitting to their neighbors,

PLATE 14.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

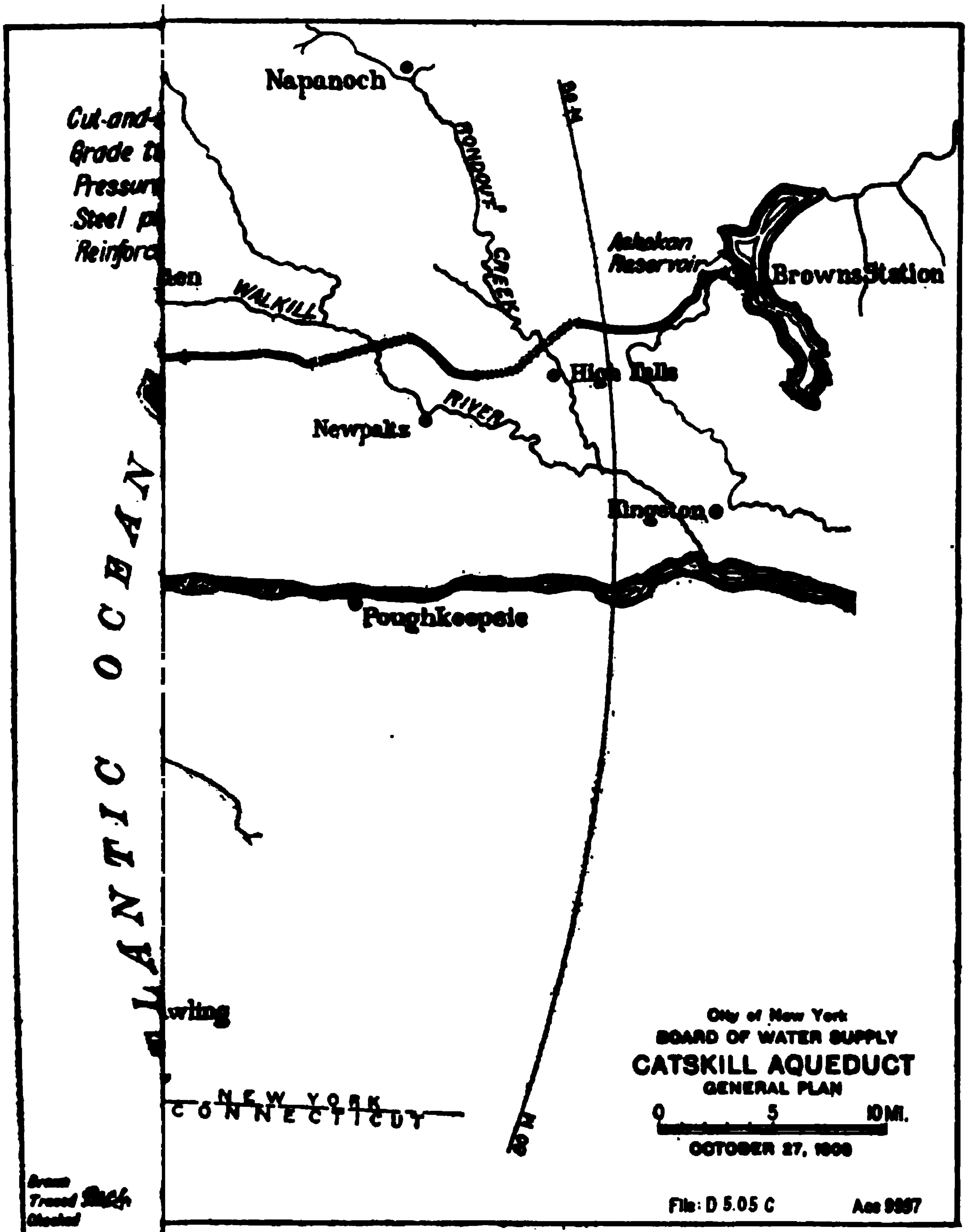
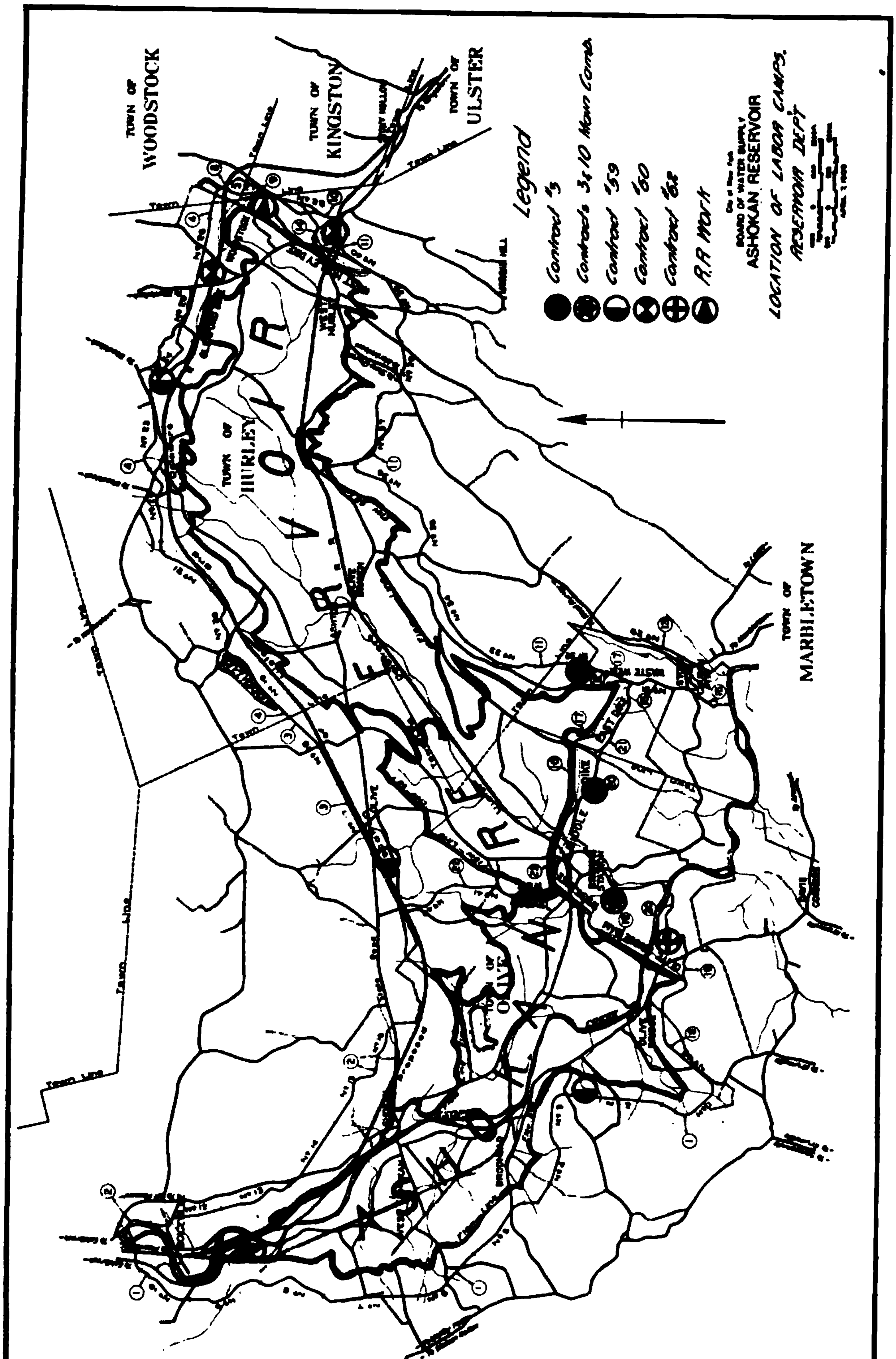


PLATE 15.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



Location of Contractor's Camps, Reservoir Department.

PLATE 16.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

by the aid of proper mosquitoes, more severe types of malarial fevers than are commonly met with in this country. If, therefore, the *anopheles* mosquito is present, the result usually is a fever-shaken camp and the prevalence in the district for many years thereafter of severe malarial disturbances.

Water Supply.—An impure water supply means an unhealthy camp. Great care must, therefore, be taken to obtain a supply of satisfactory purity, so located, handled and stored that its character may not be readily subject to deteriorating changes. There should be, if possible and practicable, but one supply furnished in any camp, and the use of all other waters should be prevented. As a rule, deep wells bored in rock or suitable water-bearing material furnish the best water from the sanitary standpoint. All such wells should be cased with iron tubing to a reasonable distance from the surfaces and all suitable precautions taken for preventing entrance of surface and shallow sub-surface waters. Where the well is drilled in rock, especial care should be taken to obtain an entirely water-tight seal near the bottom of casing.

Open dug wells are commonly met with in the country districts, but extended examination of waters collected therefrom has shown, in substantially all cases, sanitary impurity. If such wells are required to be used they should be covered, provided with suitable curbs, and the walls made impervious to ground and surface water for a distance of several feet from the top. A suitable hand or force pump should be installed for drawing the water, and the use of buckets and dippers should be in no case permitted.

Springs in sparsely settled districts frequently yield water of high natural sanitary purity. This condition is readily changed, however, by human contact, and, if used as supplies for camps, require the greatest precautions for their safe preservation. They should be enclosed with substantial, impervious masonry, and means taken to prevent removal of water by dipping. A metal pipe, serving also as an overflow, should, as a rule, provide the sole means of drawing water from the spring.

Surface waters, such as ponds, lakes, brooks and rivers, are so subject to contamination, even if naturally reasonably pure, as to render it unsafe to use such supplies without effective filtration. Whatever the supply chosen, its continued use should be subject

to periodical examinations, more or less frequent, depending upon the nature of the supply and its susceptibility to external influences.

Food Supplies.—The food supplies which require most careful attention on account of their relation to preventable disease, include principally milk and other foods naturally used in a raw state, or cooked foods which are allowed to stand and cool before being used. They may be conveniently divided into two classes: 1st. Those which in their handling or production are liable to come into contact with polluting material containing pathogenic bacteria, including milk, which may be contaminated by the hands of workmen, by adulteration with impure water, etc., and foods such as cabbage, lettuce, celery, water-cress, etc., which are sometimes fertilized with human excreta or grown in contact with sewage or polluted water. 2d. Those like bread, pastry, fruits, sugar, etc., which are likely to be exposed to flies and to become infected with typhoid, dysentery and other pathogenic intestinal bacteria.

The principal attention which it has been possible to give to these matters on the Board of Water Supply work includes: 1st. Examination of important sources of milk supplies, regulation of its production and occasional tests to determine its sanitary character. 2d. The screening, during important seasons, of foods exposed for sale. 3d. The prohibition, in certain instances, of irresponsible hucksters and pedlers from entering the camps.

The effective handling of this subject in the 75 or more construction camps is exceedingly complicated, and would involve enormous expense for proper supervision. Whatever effective work has been done along these lines could not have been accomplished without the loyal co-operation of certain contractors, whose assistance it is a pleasure to acknowledge.

Wastes Disposal.—This term may be applied to all of the rejected products from the camp; not only those of animal or vegetable origin, which in themselves may contain pathogenic organisms or which on account of putrefaction or fermentation are capable of incubating flies to serve as carriers of these infectious organisms, but also the rubbish and house dust, which are likely to become infected with sputum from tuberculosis cases, or with diphtheria and pneumonia from patients or walking cases.

PLATE 17.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

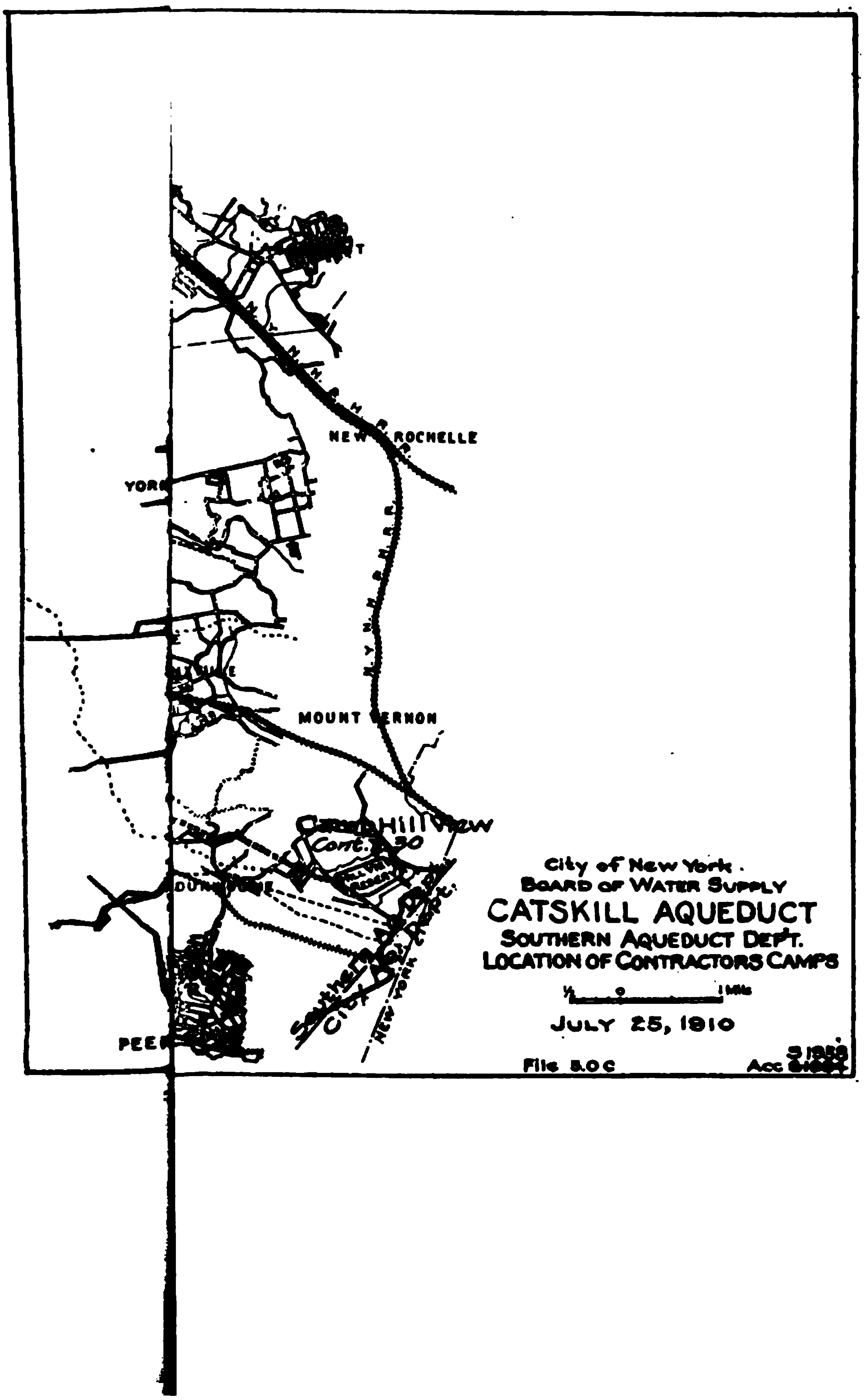
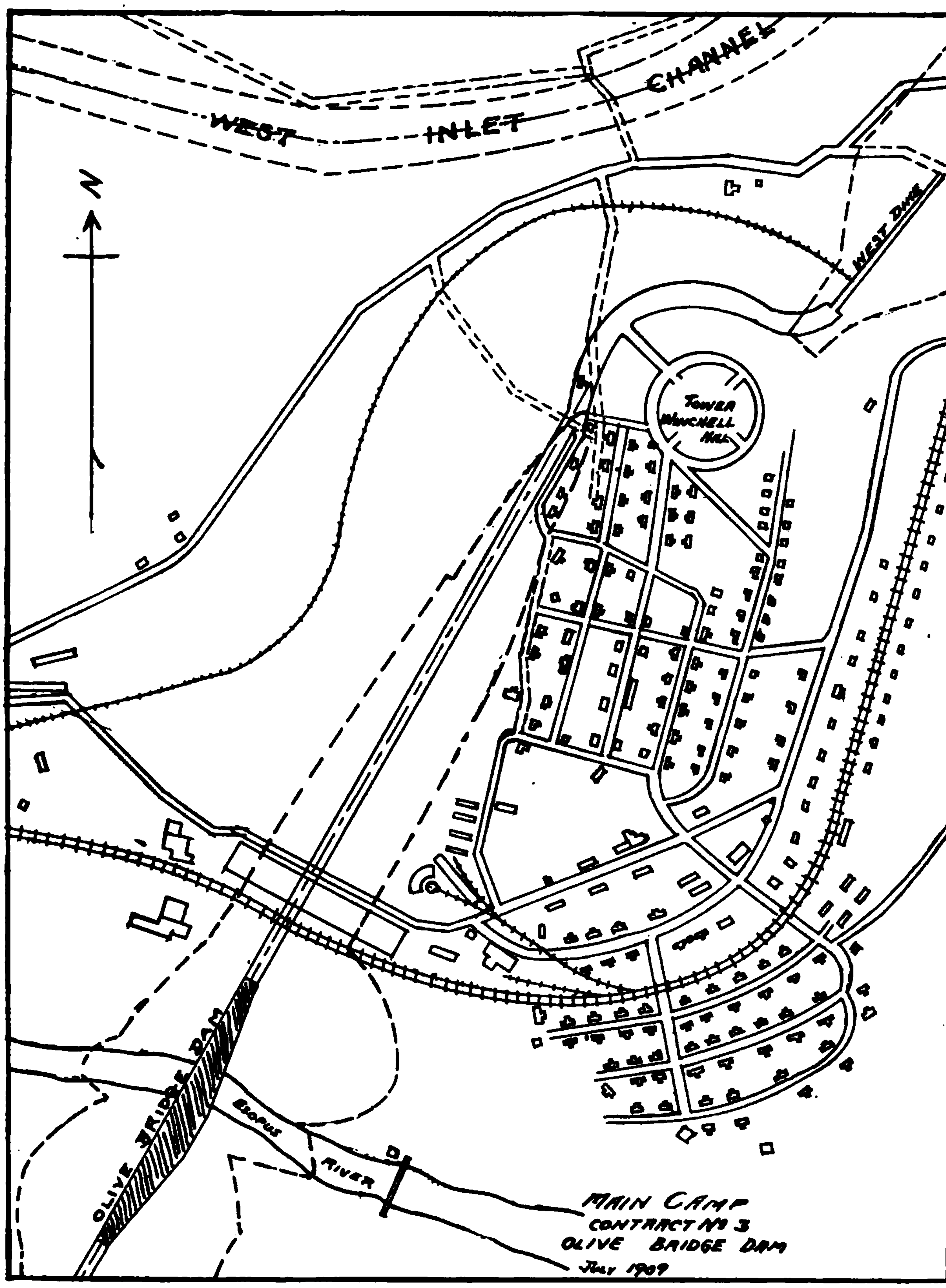
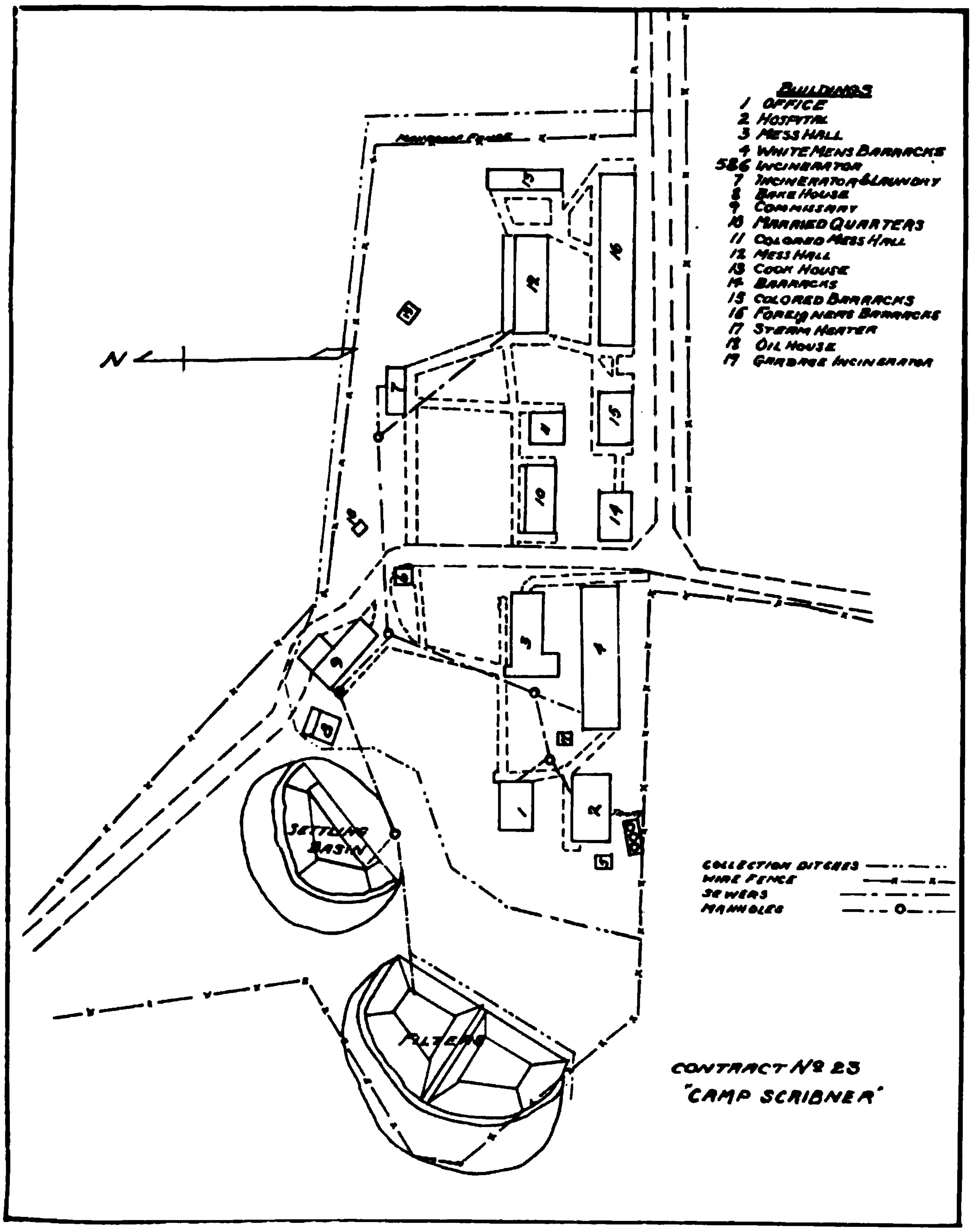


PLATE 18.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



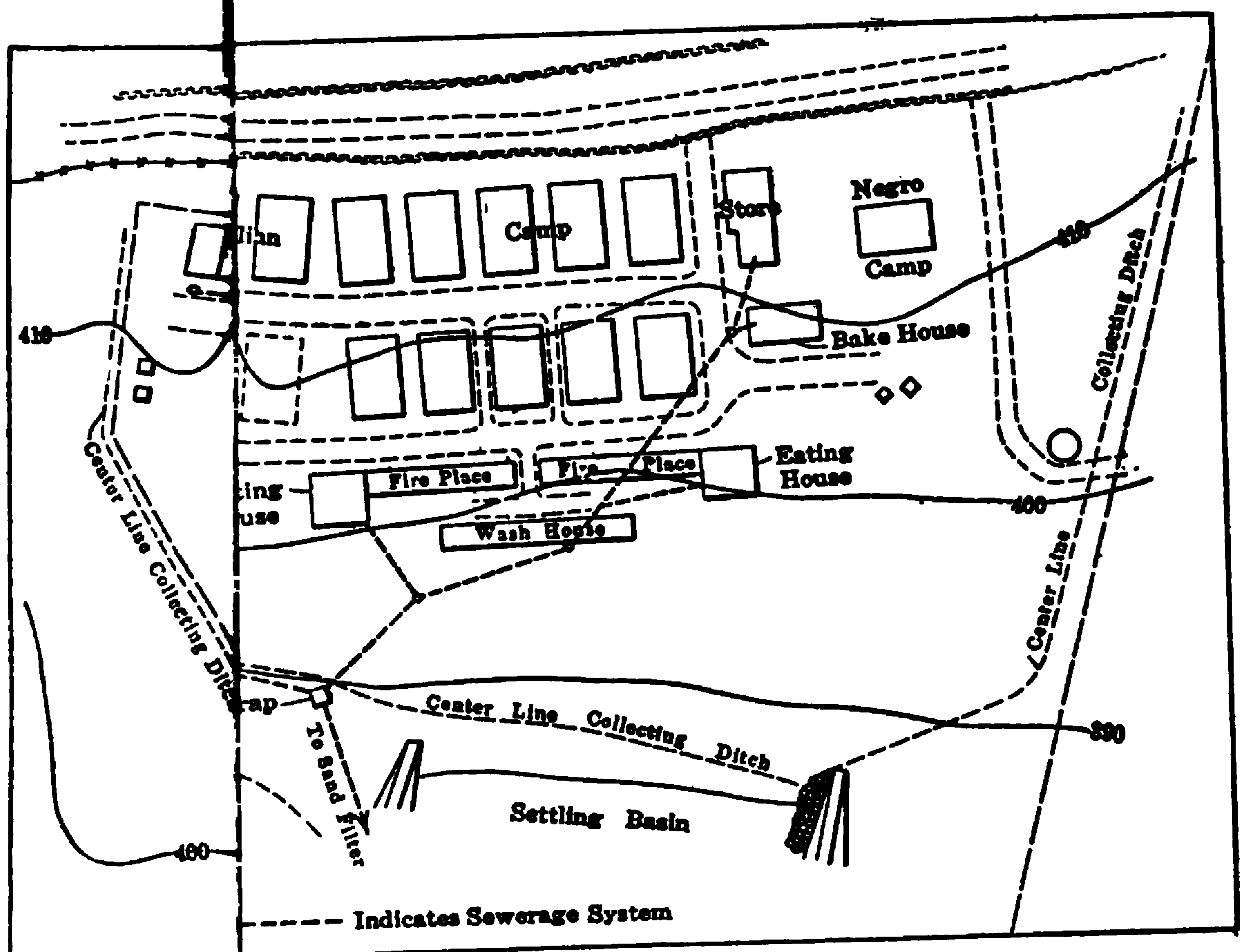
Plan of Camp Layout, Contract No. 3, at Olive Bridge Dam.

PLATE 19.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

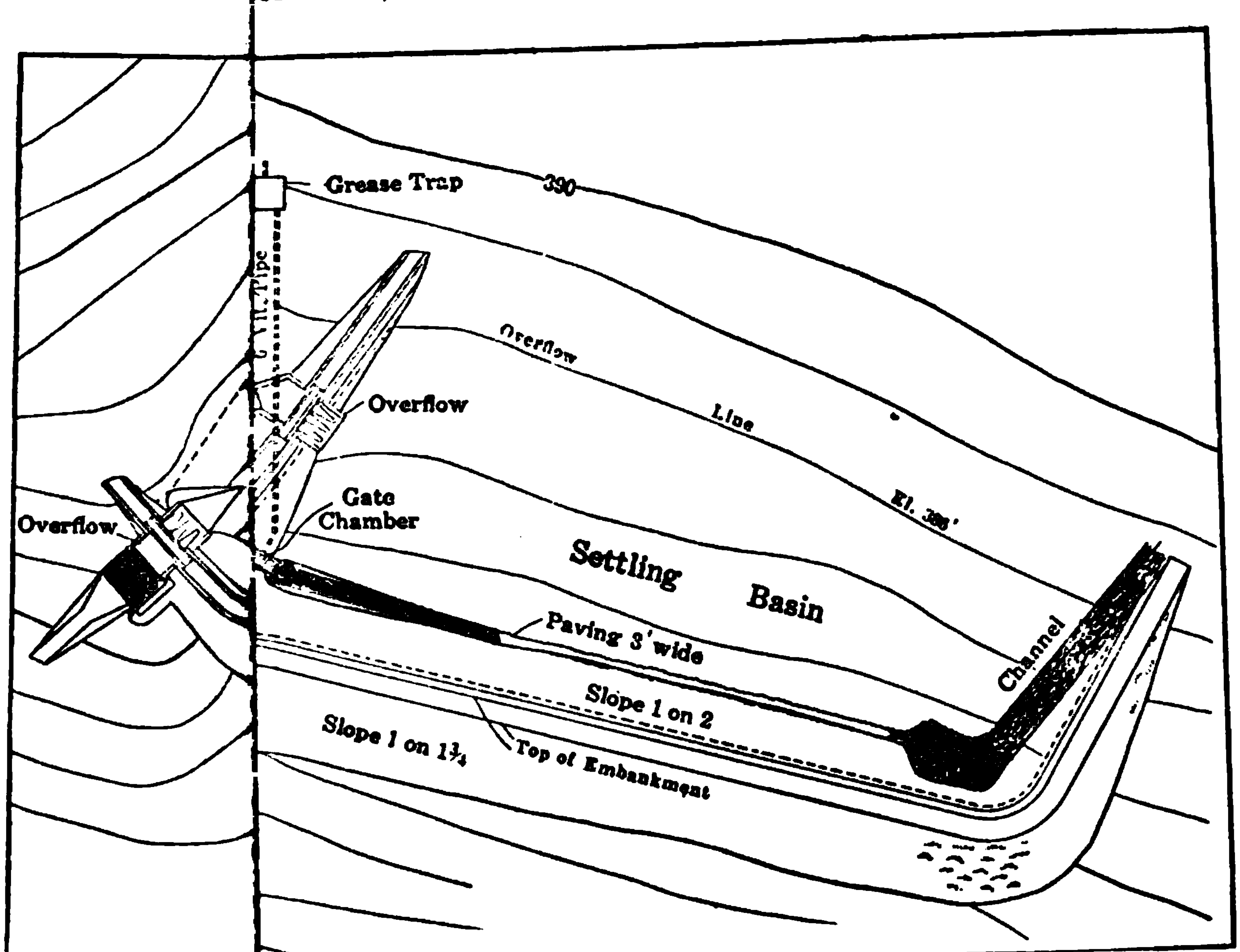


PLAN OF CAMP LAYOUT, CONTRACT No. 23, CAMP SCRIBNER.

PLATE 20.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



ct No. 25, Camp Blakeslee.



Camp Blakeslee.

These waste products may be classified in the order of their importance, as follows:

1. Human excreta and urine.
2. Surgical and medical dressings, bandages, discharges, etc.
3. Stable manure.
4. Garbage.
5. Slop water—drainage from kitchens, bakeries, laundries, wash-houses, etc.
6. Dust and rubbish.

Experience has shown that the safest and most expedient method of disposal of classes 1, 2, 3, 4 and 6 is by means of prompt, thorough incineration in approved apparatus. None of these materials have any substantial commercial value, and while in many places it is possible to induce neighboring farmers to take the manure and garbage at the cost of cartage, this service is, as a rule, so irregular and so unsatisfactory as to warrant, in view of proper sanitation, the immediate incineration of all such wastes.

In the case of human excreta and urine, prompt, total destruction by fire is the only safe course to pursue, all other methods usually available having proved unsatisfactory at some point or other in their procedure. These conclusions have been suddenly arrived at after centuries of tragic, if somewhat blind, experience.

The lesson of the past is that wherever attempt has been made to congregate the habitations of more than a very limited number of human beings or animals, there results a natural tendency toward destruction of the colony by its own discharges and waste products. This tendency is largely controlled by the introduction of suitable sewerage under proper conditions, but in many cases the fatalities and morbidities are merely transferred from the guilty colony to another down-stream. Where sewerage systems could not or have not been installed, as in temporary encampments for purposes of war, military manœuvres, expositions, or the construction and development of important industries and public works, history records in substantially all instances general prevalence of fever and pestilence, diseases now considered unnecessary and preventable.

The general practice of suppressing information in such cases has prevented even a partial understanding of these matters, and it was not until the publication of investigations made subsequent

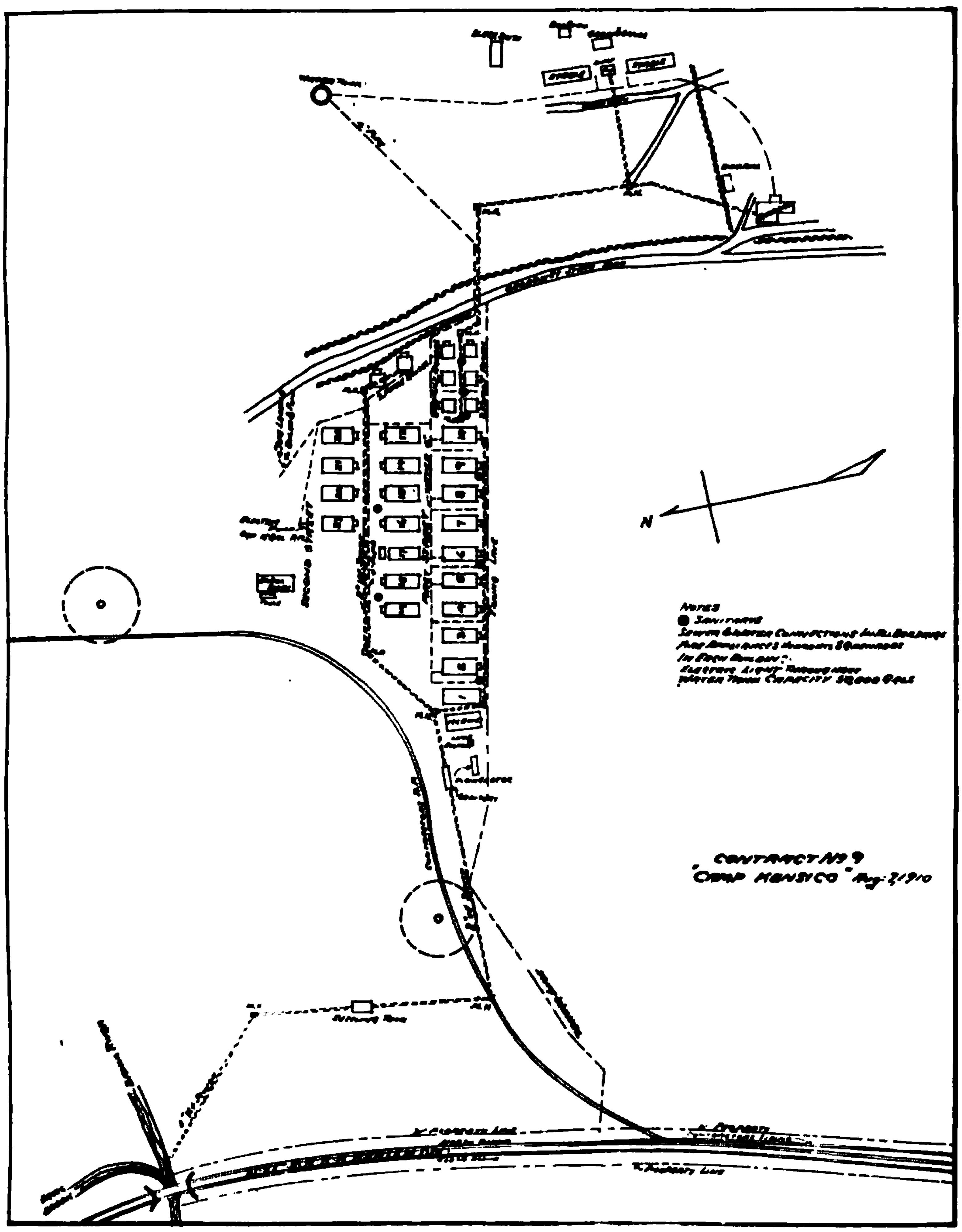
to our war with Spain that the serious and criminal side of the subject was realized by the people generally. These reports showed that more than 90% of the volunteer regiments developed typhoid fever within eight weeks after going into camp; that about one-fifth of the soldiers of the national encampments had typhoid fever, and that the mortality from this disease amounted to 86½% of all fatalities. If the investigations had been extended further, to include dysentery and other serious intestinal diseases, it is probable the results would have been even more startling. More recent studies have satisfactorily demonstrated that every case of contagious disease has its origin in some other case of the same disease; that living, virulent germs are ejected with the bodily wastes of persons sick with the particular disease, convalescent therefrom, and, in some cases, for many years thereafter; that these germs, if transmitted to other persons, have the power of producing new cases of the disease, and that the chief means of transmission, by which these germs enter our systems, are, as previously stated, through drinking water polluted by sewage in which they occur, by raw foods grown in contact with human sewage, and by food, raw or cooked, to which flies with filth-laden bodies may have access.

The practice of incineration of fecal wastes, started by the regular United States army in 1907 and now in general use in all movable camps, has resulted in the substantial disappearance of typhoid from its commands. The practice has also spread to and become adopted by numerous State militia. Pine Camp, used by the New York State regiments, is provided with apparatus for several thousand men. The types of incinerators which have been placed on the market on account of this demand, naturally follow military requirements, and are mostly of the sheet-iron portable type, being, as a rule, too light for durability under hard service.

They are all evaporative furnaces, designed to obviate the handling in any way of the material to be destroyed, and when intelligently operated without driving, produce satisfactory results.

These types have not proved entirely suitable for conditions obtaining on the Board of Water Supply work, and the general tendency, in recent installations and renewals, has been to substitute pan closets with removable water-tight receptacles, and to incinerate

PLATE 21.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



Plan of Camp Layout, Camp Kensico.

PLATE 22.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

GENERAL VIEW OF CAMP BRADLEY, NORTH OF CROTON LAKE. INCINERATOR HOUSES AT THE RIGHT. CONTRACT NO. 24.

TYPES OF INCINERATORS.

the material in specially designed masonry furnaces on grate bars in direct contact with the flame. Where the pan closets are housed in the same building with the furnace, as originally designed by Mr. L. C. Brink for Camp East View, Contract No. 52, Pittsburgh Contracting Co., and since installed on other contracts, and where a proper amount of suitable sawdust is used to hold the material on the grate bars, the results produced are superior to those obtainable on this work by the sheet iron evaporative furnaces of the army type.

The men employed to operate the furnaces of the various types are usually of the lowest price of labor, frequently incapable of understanding directions given in English, and to this condition is probably due the complaints of odor during burning, which have been quite general. Advocates of incinerators meet these complaints by contending that odors, if necessary, are preferable to typhoid and dysentery, and that, with intelligent operation, odors are unnecessary. This latter contention appears to be sustained by army experience.

In any event, there can be little doubt that the comparatively low typhoid morbidity on the Board of Water Supply work during the past one and one-half years has been largely due to the increasing and now quite general practice of incinerating excrementitious wastes. The fairly general practice of burning garbage and rubbish, the prompt removal or incineration of stable manure, and the insistence upon screening, have no doubt also contributed to the excellent result.

For the disposal of liquid wastes, other than excrementitious wastes, the method adopted as most feasible and practicable has been to collect them in suitable drains from plumbing fixtures or outdoor slop sinks, to provide a settling basin with grease trap for a retention period of three or four hours, and duplicate sand filters. The resulting filtrate is suitable for discharge into any watercourse not used as a potable supply; otherwise final sterilization should preferably be employed.

In cases where suitable collection and treatment of liquid camp wastes have not been provided, the omission is keenly felt.

Ventilation, Lighting and Heating.—Human vitality cannot be suitably maintained nor maximum work performed without rest

and recreation, under conditions which provide abundant fresh air at a proper temperature. These conditions require a definite amount of space, provisions for the ingress and egress of atmospheric air, means for admission of sufficient direct solar light, and methods of artificial heating and lighting which will not vitiate the air to an undesirable extent.

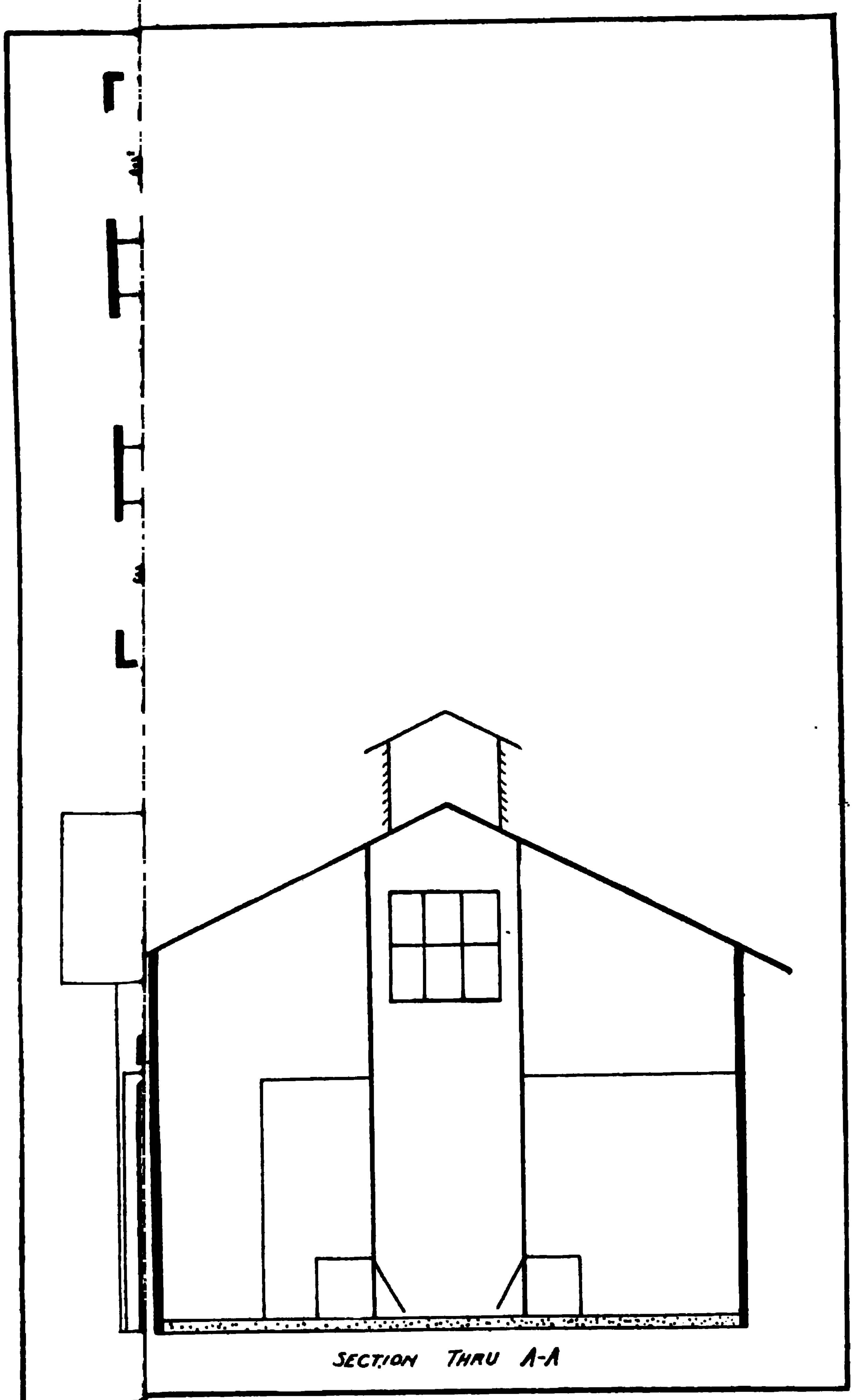
In fixing the minimum allowable capacity of sleeping quarters at 400 cu. ft. per inmate, it was essential that some method of ventilation should exist additional to that furnished by the walls and casings of doors and windows, even in such rudely and cheaply constructed houses as were to be provided.

Space, circulation of air and means of ventilation have usually been secured by terminating the interior partitions at the plate level, leaving the rooms open above to the roof, and by placing on the peak a louvre vent, having a free horizontal area of about ¼ sq. ft. per inmate. The houses are in all cases detached, having light from four sides, and the glass area of windows is in general about 3 sq. ft. per inmate. Due to lack of adequate artificial heat in winter, and, in some cases, to its total omission, the attempts at ventilation have been, in some instances, defeated by the inmates nailing boards over or otherwise closing the vent opening, but this is only one of many instances where it is easier to plan matters of camp hygiene than to accomplish their entirely satisfactory maintenance. The increasing interest being taken by the welfare committees of sociological and immigration societies in behalf of the laborer is a force to be taken into account, and it appears likely that future labor camps on important public works will, in their contribution to the comfort of the inmates, go far beyond what is now considered feasible and practicable.

The past estimate placed by engineers and contractors upon the unskilled labor at their command has been that he is somewhat related to a brute in his preferred method of living, and that when off duty he is either indifferent to his surroundings or else is principally concerned as to how he can most rapidly separate himself from his last pay check.

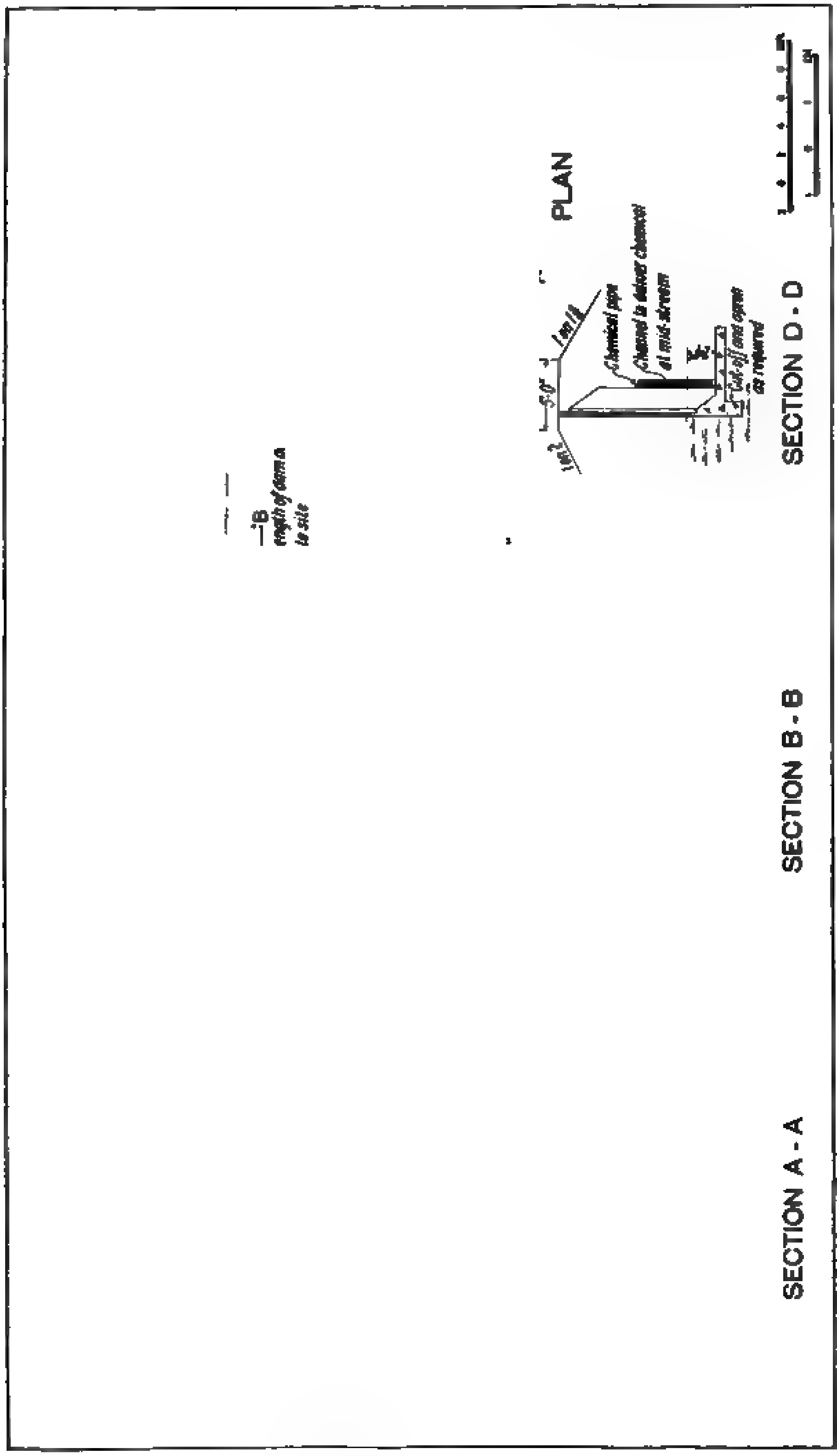
The societies mentioned above are, however, working upon the theory that by education and diversion they can transform the man and his family into self-respecting human beings. Schools and

PLATE 24.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



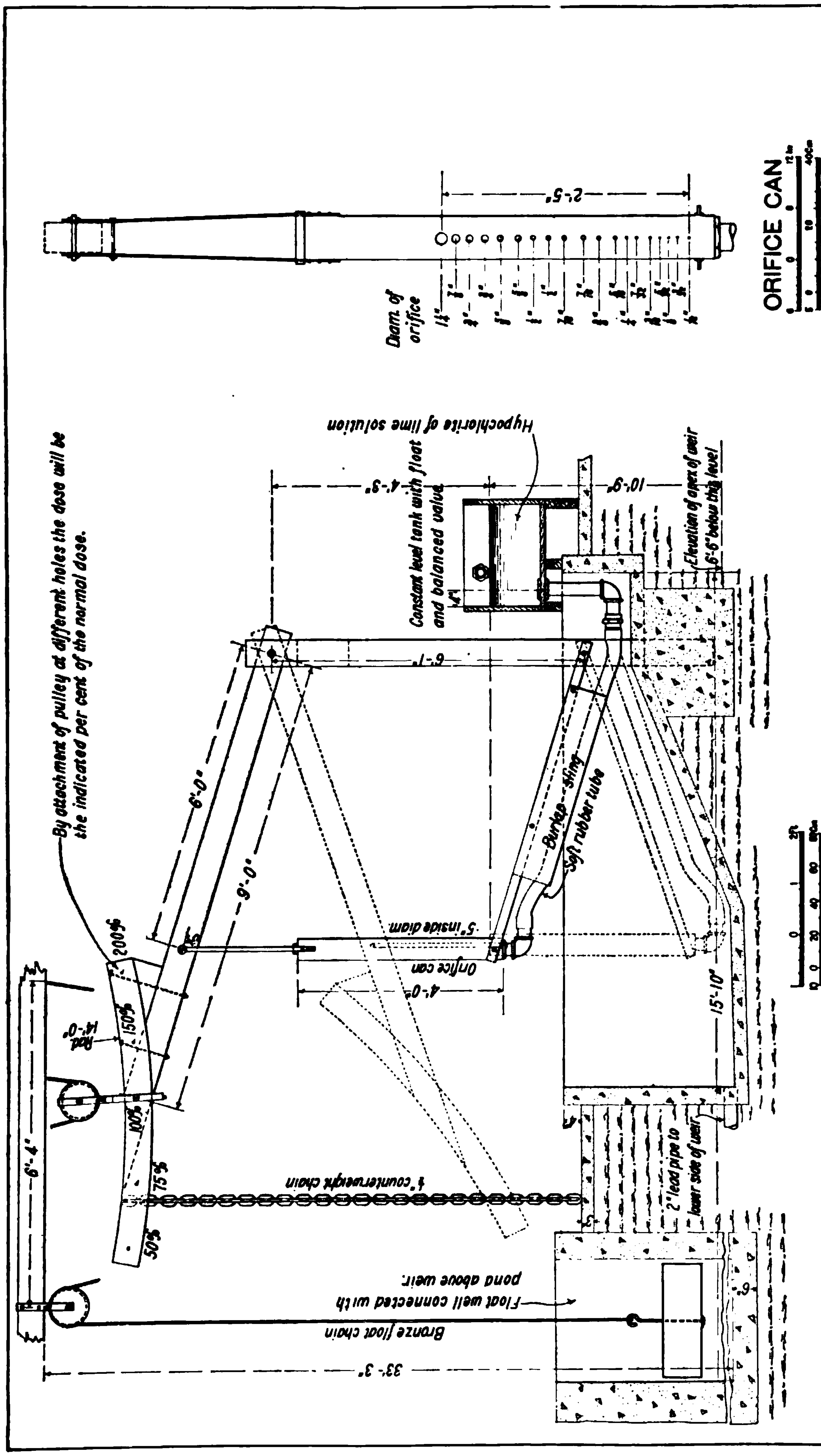
SPACE NOT SHOWN.

PLATE 25.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



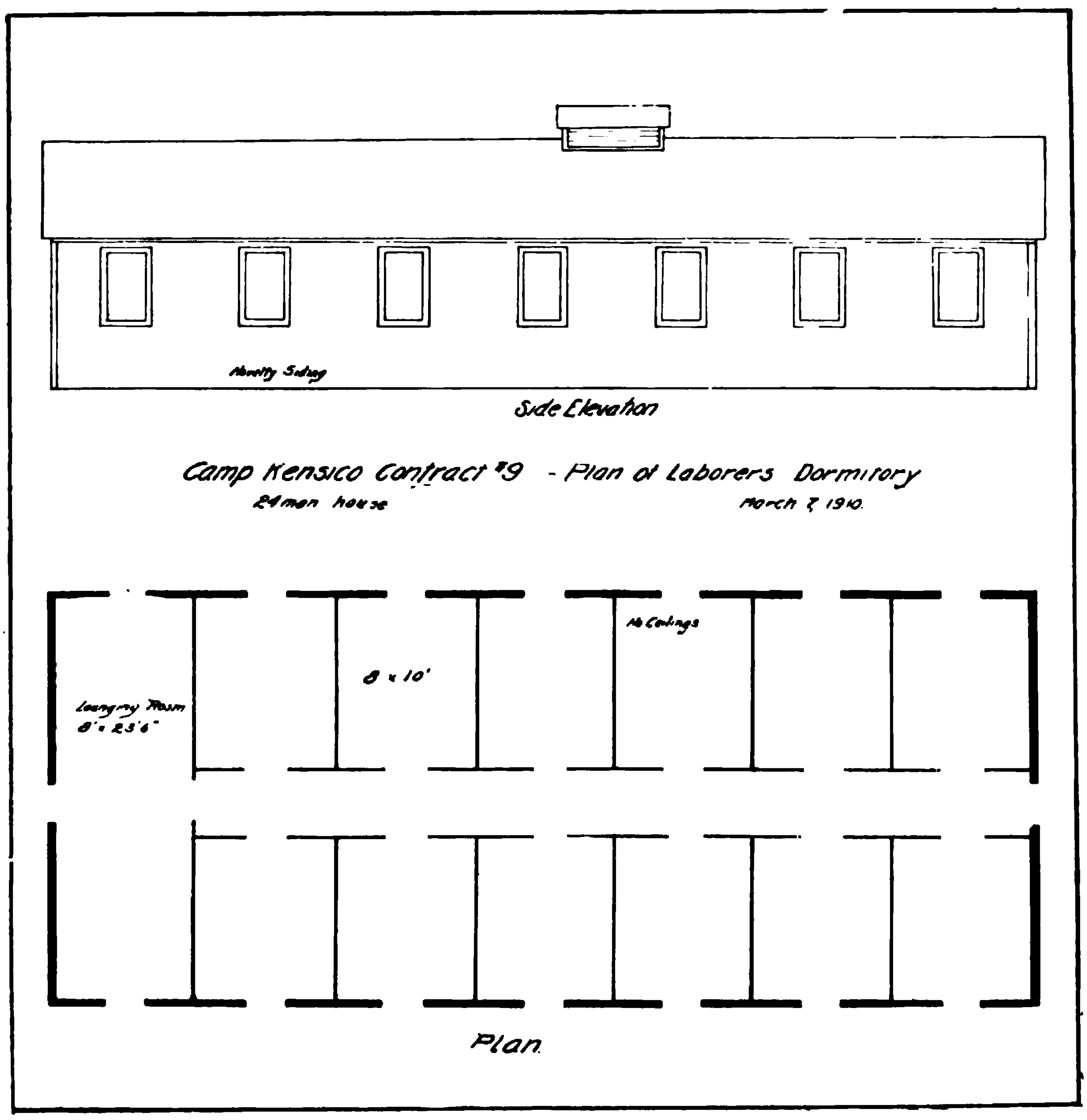
Sterilizing Apparatus at South Portal of Hunter's Brook Tunnel.

PLATE 26.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



Dosing Apparatus for Sterilizing Solution at South Portal of Hunter's Brook Tunnel.

PLATE 27.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY



LABORERS' DORMITORY, CAMP KENSICO.

ai
ir
of
tl
fc

te
m
w
s
l
p
s
t
t

amusements for adults and children have been and are being started in some of the larger camps, usually with the financial assistance of the contractor. What the result may be cannot now be more than guessed at, but if successful, it will mean the entire transformation along sociological lines of future important labor camps.

Assuming that a camp has been constructed with all the appurtenances and precautions considered by us this evening, provision must next be made for admitting its inmates under conditions which will, so far as practicable, exclude people who may be a menace to the health of the camp, and under conditions which will secure, so far as practicable, their compliance with reasonable sanitary regulations. For these purposes there is provided in all contracts a practicing physician; in some camps man-proof fences are constructed to keep the inmates within bounds, and in all instances there is available the Aqueduct Police for enforcing discipline, and the local courts for the punishment of confirmed offenders.

Medical Supervision and Immunization.—For a number of years it has been quite customary for contractors employing large numbers of men to provide service of some kind for medical and surgical treatment. For such service it has been customary to charge employees a fixed weekly or monthly sum. It should be noted, however, that this arrangement did not usually cover the employee's family, and that it dealt only in curative and operative medicine, and not, to any extent, at least, in preventive medicine. On the Board of Water Supply work the medical provisions have been added to the sanitary work, and particular emphasis has been given to the prevention and control of contagious, infectious and communicable diseases. Each of the 26 construction contracts has one or more physicians, whose duty it is to examine for approval the physical condition of all applicants for employment, and to immediately vaccinate and to issue a proper certificate to each man employed, as well as to each member of his family, if they enter the contractor's camp. Certificates of vaccination held by the applicant are accepted if issued by some other physician on Board of Water Supply work within one year of the date thereof. Applicants who are open cases of tuberculosis, syphillis, etc., are subject to rejection by the physician.

Hospital.—At approved locations on each contract there are one

or more buildings designed and equipped for hospital purposes. These are usually provided with a doctor's office and dispensary, an operating room with surgical table and instruments, a ward with 600 cu. ft. capacity for 2% of the force, an isolation ward of about 1 200 cu. ft. capacity, one or more rooms for nurses or orderlies, a bathroom, linen closets and storage room for surplus cots, blankets, etc. Running water is furnished in dispensary or operating room and bath. These buildings are equipped with heating apparatus, and most are lighted by electricity.

Supplies of vaccine, diphtheria and tetanus antitoxines, anti-streptococcus serum and typhoid vaccine are furnished to the contractor without charge by the New York City Department of Health, in order that these may be fresh and of proper quality. All other supplies are furnished by the contractor.

Isolation Hospital.—An additional building is also provided on most contracts and kept ready for use when required as a pest house. This is usually a small structure, consisting of a ward, a room for nurse or orderly, and a kitchen. It is desirable that this building be somewhat remote from habitations and in some cases it has been surrounded by a man-proof fence for the purpose of making the isolation effective. Where considered necessary, a constant day and night patrol by Aqueduct Police has been maintained during the period of quarantine. The contractor's physician is charged with the duty of inspecting all camp buildings, including living quarters, toilets, wash-houses, mess halls, stables, etc., and is responsible for their cleanliness. He is also responsible for satisfactory operation of incinerators and garbage furnaces, and for screening of buildings, the protection and handling of garbage, the destruction of wastes, and for the general condition and appearance of the camp grounds.

Weekly reports in prescribed form, covering camp population, total number of employees, vaccinations, medical cases, surgical cases, deaths, transfers, sanitary condition of camps and works, etc., are required from the contractors' physicians. Where the camps or works are located within the watersheds of public supplies there is also required the name and residence of each employee not living in camp. Cases of contagious, infectious or communicable diseases of the several classes are reported immediately

PLATE 28.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

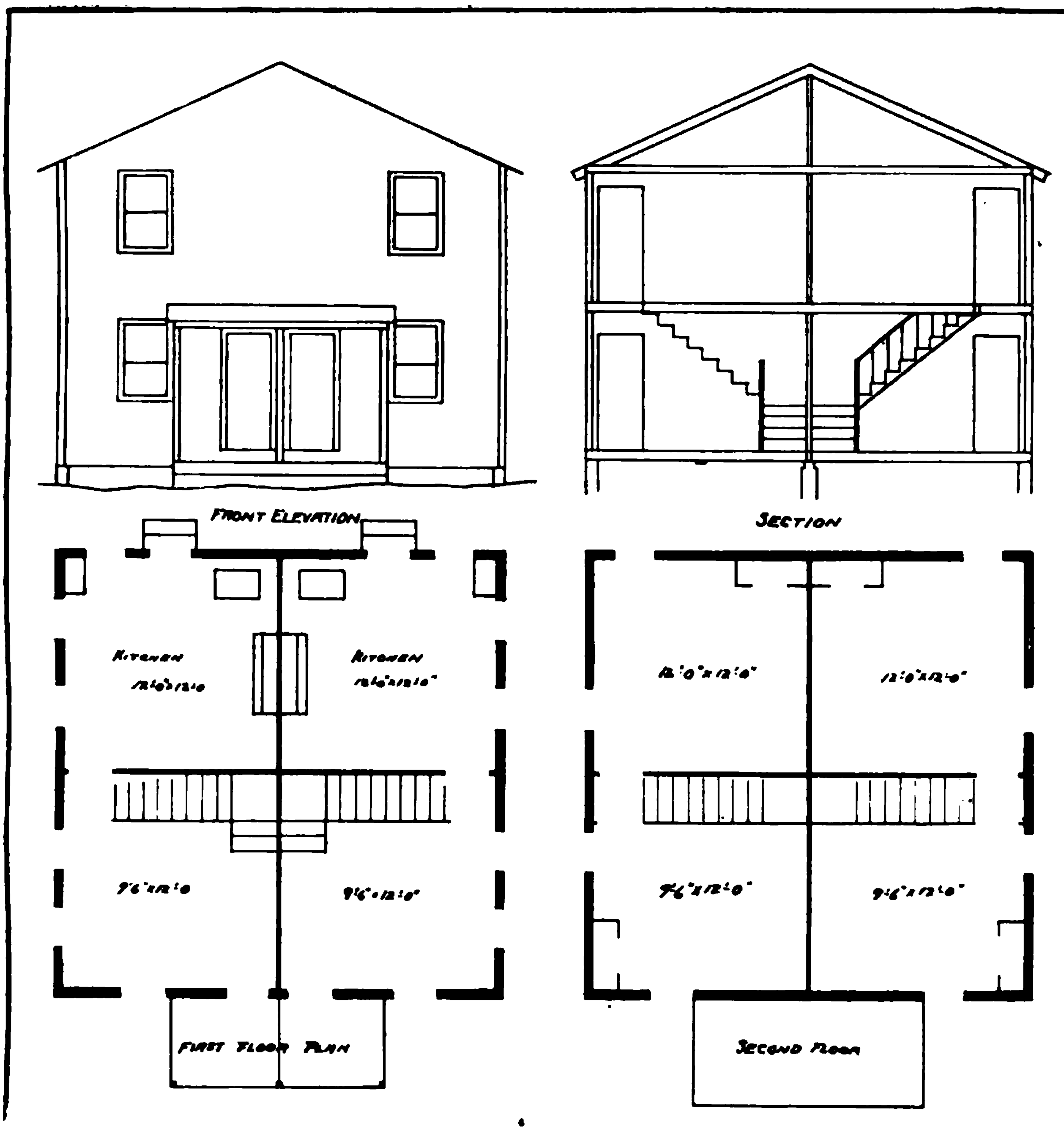


FIG. 1.—TWO FAMILY HOUSE, CAMP KENSICO.

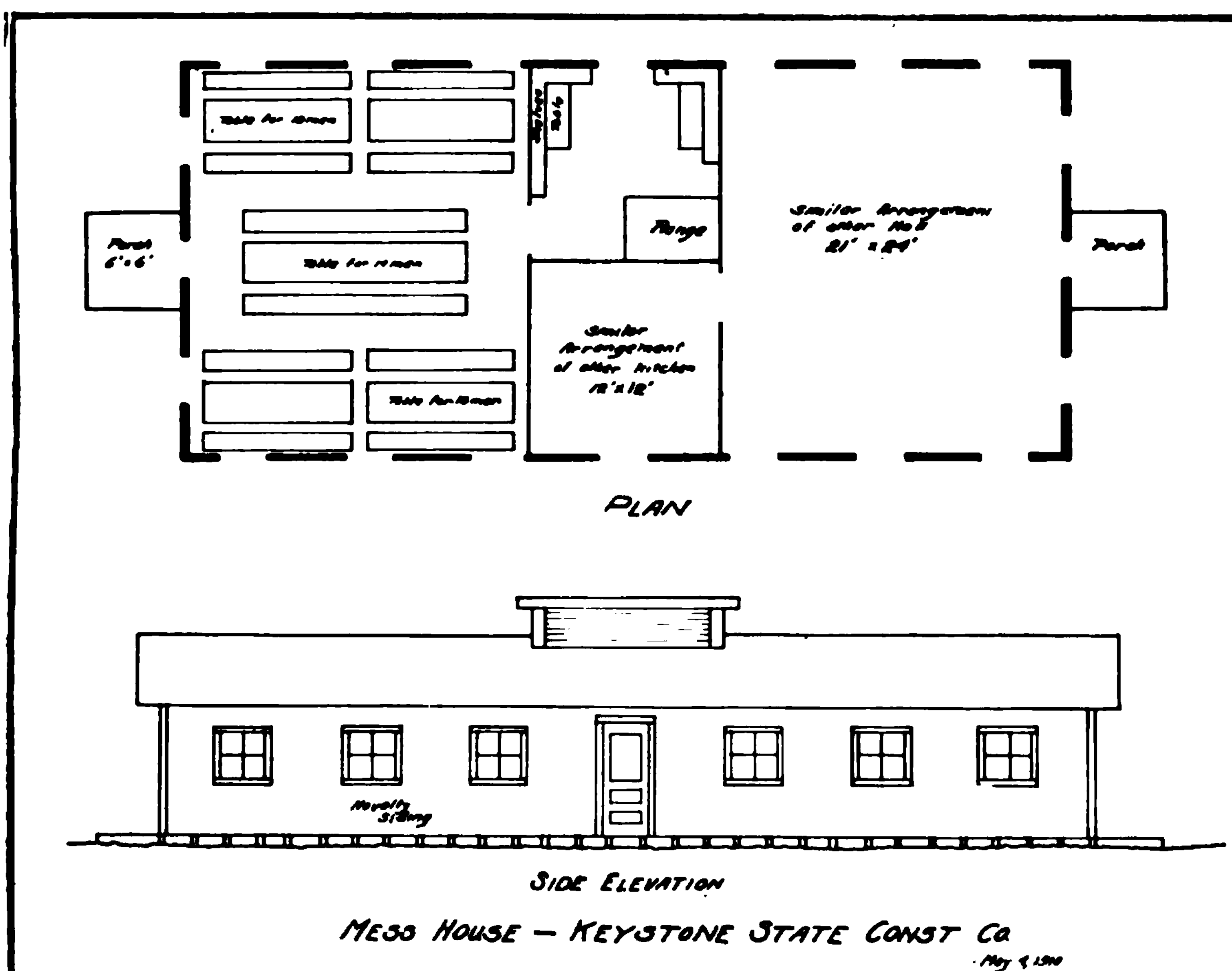


FIG. 2.—MESS HOUSE, CAMP HILL VIEW.

PLATE 29.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

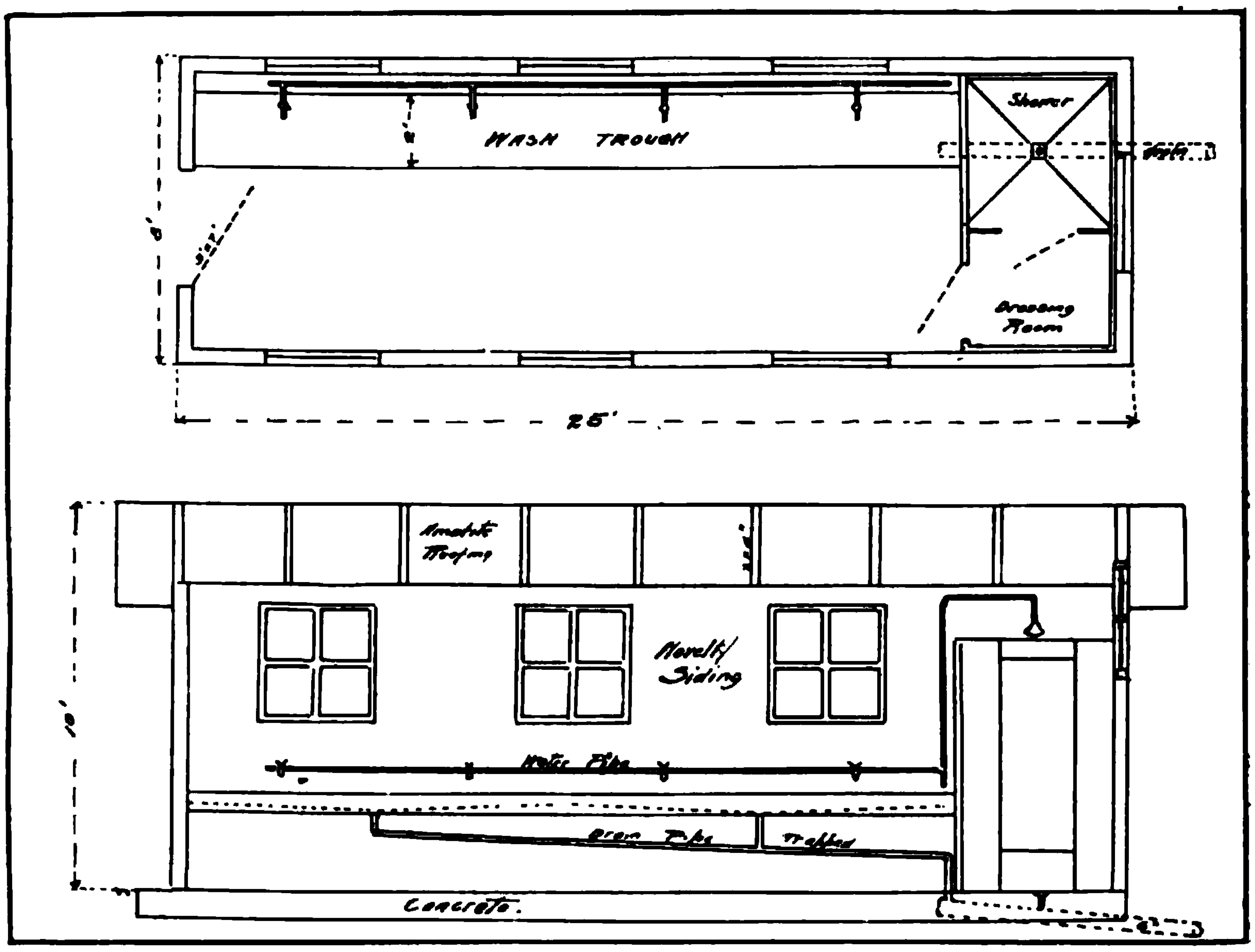


Fig. 1.—Wash House, Contract No. 80, Camp Hill View.

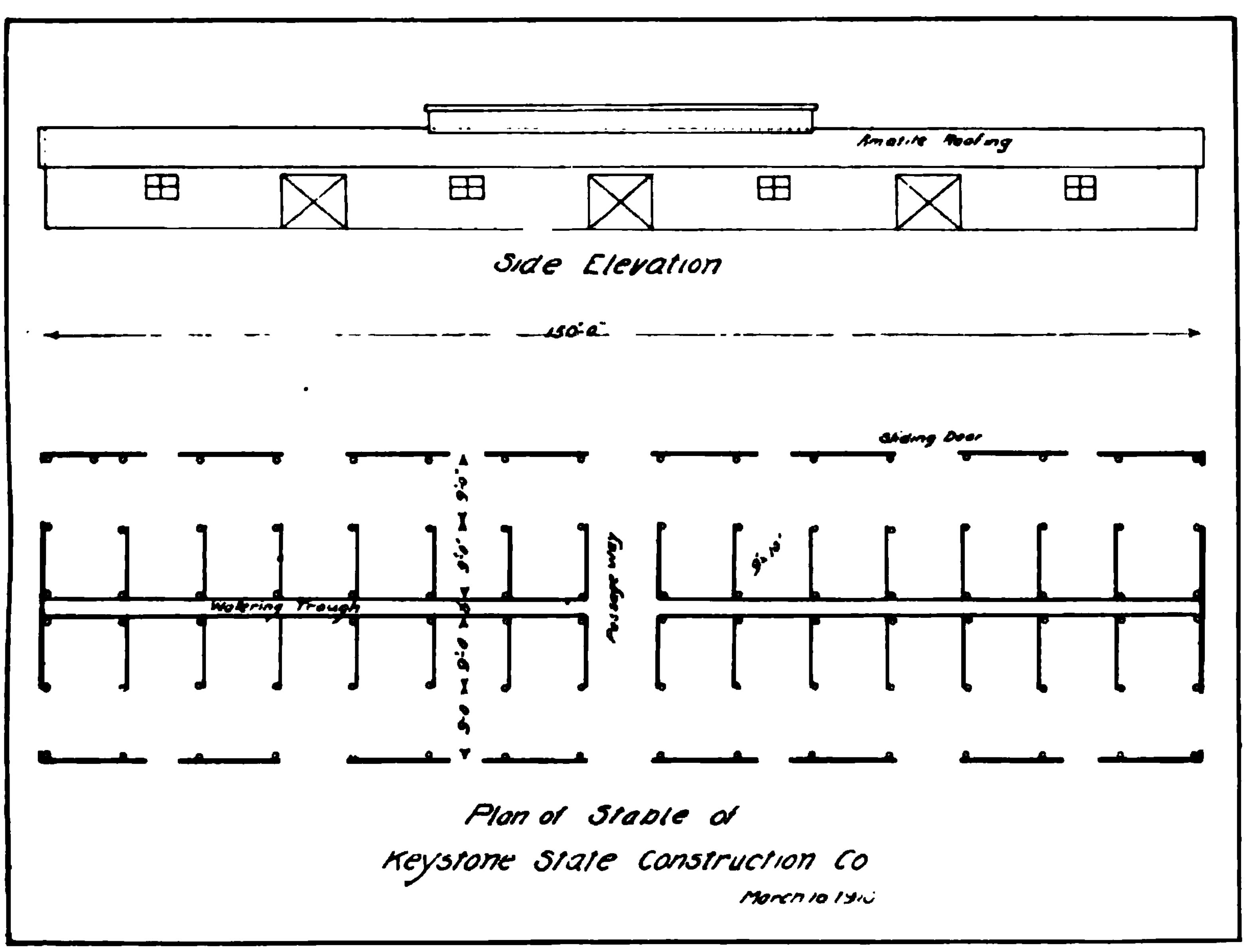
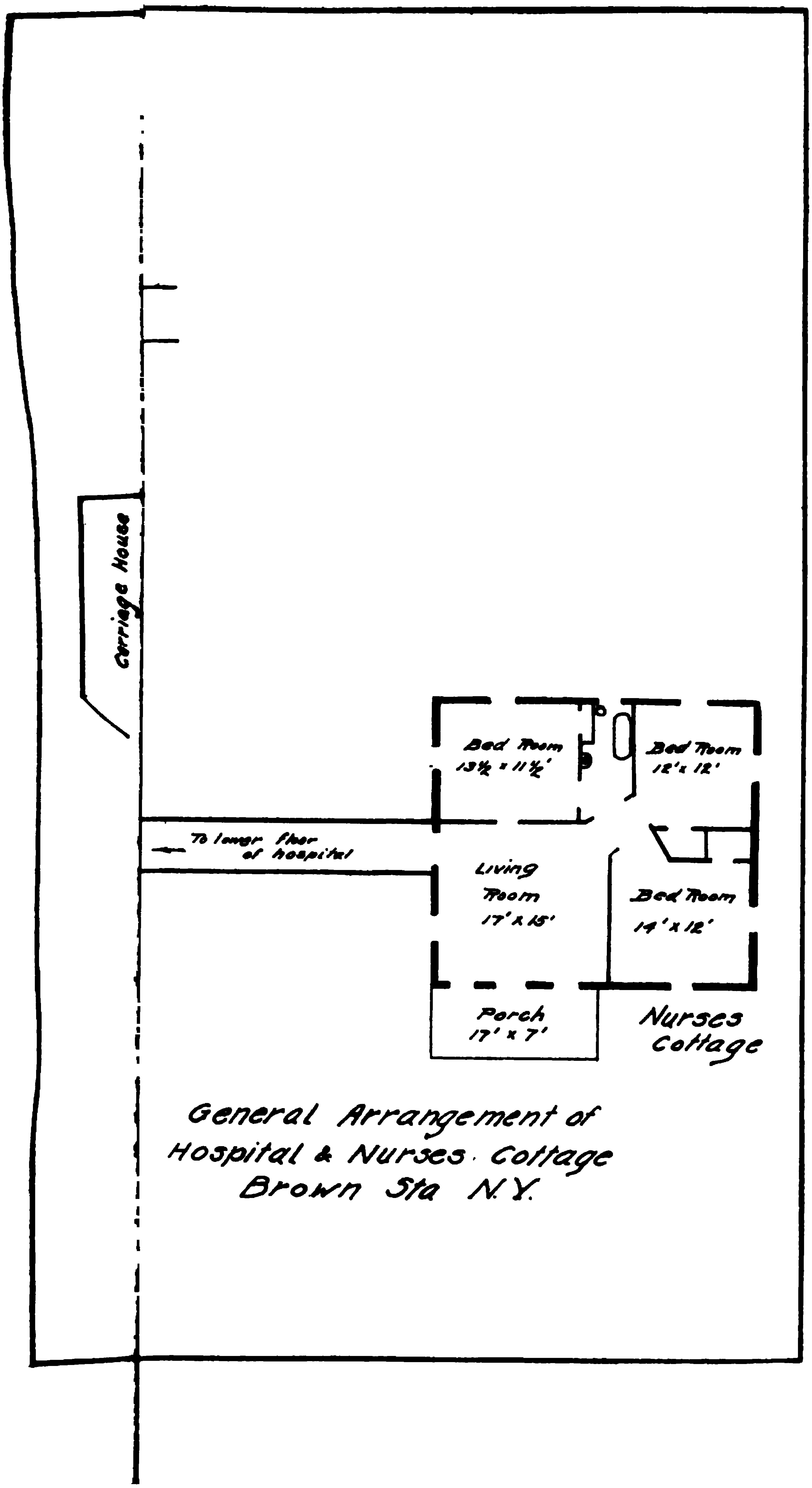


Fig. 2.—Stable, Camp Hill View.

PLATE 30.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.



General Arrangement of
Hospital & Nurses Cottage
Brown Sta N.Y.

after tentative diagnosis by telephone or telegraph, using prescribed code.

In suspected cases of tuberculosis, diphtheria, typhoid, fatal dysentery, etc., samples of sputum, membrane, blood or fecal, as the case may be, are forwarded for laboratory examination, in order that positive, prompt diagonsis may be possible and effective means for controlling the disease immediately taken.

Within the limits of the Croton watershed there has been to date, among the entire force, including employees of the City, but one case of typhoid, and that was positively identified by Widal reaction within three hours, and the case moved to a hospital outside the watershed within 20 hours after sample of blood was drawn by the physician.

Special Sanitary Precautions.—These relate particularly to sections of the work lying within the sheds of important water supplies. These include special care in the selection of the camp sites and their location with respect to the work; the transfer of men between the camp and work; the limitation placed upon the number of men and the class of labor permitted to live on the watersheds outside of the camps, as well as their weekly registration; more rigid enforcement of cleanliness throughout the camp buildings and grounds; the illumination of camp area; the prohibition of outdoor cooking ovens; the regulation of food storage and consumption by providing mess halls; the compulsory, regular incineration of excrementitious wastes and garbage; the prompt removal or destruction of manure, as well as special attention to stable design; the collection, sedimentation, filtration and sterilization of domestic liquid wastes, as well as all rain water falling on the camp area within the man-proof fence; special sanitary precautions along the line of the work, including filtration and sterilization of mine water and storm wash from spoil banks; the vigorous prosecution and punishment of camp inmates and employees violating the sanitary rules, and the employment of a resident physician always on duty.

All of these precautions, or as many as are deemed requisite, are taken in each particular instance.

Watersheds Occupied.—City of Kingston.—Occupied by portions

of Contracts 59 and 60. Precautions were here taken to locate the camps off of the shed.

City of Newburgh.—Occupied by portion of Contract 62—Washington Square siphon. Precautions taken here to house laborers off the shed; present force about 65 men.

Indian Brook.—Private supply. Occupied by portions of Contracts 2 and 62. Precaution taken to extend intake pipe to point above line of work and drainage from camp. Present force about 35 men.

City of Peekskill.—Filtered supply. Shed occupied by portions of Contracts 2 and 62. Precaution taken to house men off the shed so far as practicable. Present force about 100 men.

City of New York.—Croton supply. This shed is occupied for a distance of about 10 miles by Contracts 2, 68, 23, 24 and 25, employing about 1 300 men, mostly housed in 5 regulated camps, having about 1 220 inmates. All of the precautions enumerated under "Special Sanitary Precautions" are here provided and carefully maintained, under provisions which compensate the contractor directly for installation and maintenance, except in the case of Contract 2, the first Aqueduct contract awarded, from which there are housed within the Croton shed about 150 men in camps, which are regulated as fully as the terms of the contract will permit. On Contracts 23, 24, 25 and 68 the camp sites were leased by the contractors after the most careful consideration had been given to the most suitable location for each. Substantially all employees are required to live within these camps. Those exempted from this rule are of the highest grade, most of whom occupy their own houses, the location of each of which is shown on an official plan and reported each week in the physician's report. On all of these contracts daily incineration of excrementitious wastes is required. All burn the camp garbage and rubbish in approved pit furnaces of the army type. Each contract has a physician, who is required to be within one mile of the camp at all times and always on duty. All of the camp grounds are required to be illuminated from sunset to sunrise with electric lights, and each camp is surrounded by a man-proof fence.

Sanitary works are provided in all of these camps for the treatment and purification of rain water and waste water. Without

Types of Existing Houses Remodeled for Use as Hospitals; Northern Aqueduct Department.

FORM [illegible] CONTRACT NO. ______, PAGE 1 OF 4 ______

BOARD OF WATER SUPPLY—CITY OF NEW YORK
ENGINEERING BUREAU

__________________ (PLACE) __________ (DATE) 191__

____

__________________ SANITARY EXPERTS.

WEEKLY REPORT OF CONTRACTOR'S PHYSICIAN FOR WEEK ENDING __________________ 191__

CONTRACTOR __________________ CONTRACT NO. ______

THIS REPORT COVERS ______ CAMPS OF THIS CONTRACT AS ENUMERATED BELOW.

CAMP __________________ (GIVE LOCAL NAME AND LOCATION)

NUMBER OF PERSONS LIVING AT THIS CAMP:

WHITE:—MALE ______, FEMALE ______, CHILDREN ______, TOTAL ______,

BLACK:—MALE ______, FEMALE ______, CHILDREN ______, TOTAL ______, TOTAL ______

NUMBER OF EMPLOYEES NOT LIVING AT CAMP, IN THIS VICINITY __________________

CASES UNDER TREATMENT:

(NAME) (EXTENT OF INJURY) (PRESENT CONDITION)

SURGICAL __________________

(NAME) (NATURE OF AILMENT)* (PRESENT CONDITION)

MEDICAL __________________

TRANSFERS __________________ (IF PATIENTS HAVE BEEN SENT TO OTHER HOSPITALS, GIVE NAMES AND AILMENT ALSO LOCATION OF HOSPITAL)

NUMBER OF PERSONS ADMITTED TO CAMP AND WORK SINCE LAST REPORT __________________

NUMBER OF THESE ADMITTED ON CERTIFICATE OF VACCINATION FROM OTHER B.W.S. CONT'RS PHYS'NS ______

NUMBER OF VACCINATIONS PERFORMED SINCE LAST REPORT ______

DEATHS: __________________ (GIVE CAUSE FOR SAME AND FULL NAME)

REMARKS:—__________________ (IN ADDITION TO THE ABOVE STATE BRIEFLY THE SANITARY AND HEALTH CONDITIONS OF THE CAMP AND EMPLOYEES)

*INFECTIOUS DISEASES:

"A" CONTAGIOUS (VERY READILY COMMUNICABLE);—MEASLES; SCARLET FEVER; SMALL POX; CHICKEN POX, TYPHUS FEVER; RELAPSING FEVER.

"B" COMMUNICABLE;—DIPHTHERIA (CROUP); TYPHOID FEVER; ASIATIC CHOLERA; TUBERCULOSIS; PLAGUE; TETANUS ANTHRAX; GLANDERS; EPIDEMIC CEREBRO SPINAL MENINGITIS, LEPROSY, INFECTIOUS DISEASES OF THE EYE; PUERPERAL SEPTICAEMIA; ERYSIPELAS; WHOOPING COUGH; EPIDEMIC PARALYSIS (POLIOMYELITIS); CANCER. PELLAGRA AND PNEUMONIA.

"C" INDIRECTLY COMMUNICABLE:—(THROUGH INTERMEDIARY HOST); YELLOW FEVER; MALARIAL FEVER; HYDROPHOBIA.

ATTENTION IS CALLED TO THE REQUIREMENT THAT IF ANY CASE OF COMMUNICABLE DISEASE BE DISCOVERED, OR ANY CASE OF DOUBTFUL DIAGNOSIS, IT SHALL BE REPORTED AT ONCE TO THE ENGINEER BY TELEPHONE OR MESSENGER AND CONFIRMED IN WRITING.

IT IS UNDERSTOOD THAT THE TERM "COMMUNICABLE DISEASE" IN THE SPECIFICATION REFERS TO ALL INFECTIOUS DISEASES AS ENUMERATED BELOW

RESPECTFULLY SUBMITTED,

____
CONTRACTOR'S PHYSICIAN

FORM OF WEEKLY HEALTH REPORT FOR ALL CONTRACTS.

PLATE 33.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

FORM 396 E
LAB. NO.

BOARD OF WATER SUPPLY
NEW YORK CITY

INFORMATION RELATING TO SAMPLE OF WATER

CONTRACT NO.

CAMP

LOCATION AND DESIGNATION OF WATER SUPPLY

WATER FROM { TUBE WELL / DUG WELL / SPRING / LAKE OR POND / STREAM / CISTERN } DISTANT FROM IN FEET { HOUSE / STABLE / SEWAGE DISPOSAL SYSTEM / PRIVY / CESSPOOL / DRAIN }

COLLECTED BY

IF FROM WELL, GIVE APPROXIMATE DEPTH

GIVE ON REVERSE SIDE A BRIEF DESCRIPTION OF THE GENERAL SLOPE OF THE LAND, AND MAKE A ROUGH DIAGRAM SHOWING LOCATION OF THE WATER SOURCE IN RELATION TO DWELLINGS, STABLES, PRIVIES, ETC., WITH RELATIVE ELEVATION OF EACH

INFORMATION BLANK FOR WATER SAMPLES.

PLATE 34.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

Fig. 1.—Camp at Cornwall, on Contract No. 20.

Fig. 2.—Camp Blakeslee, on Contract No. 25.

going deeply into the design of these several appurtenances, it may be stated that diverting ditches are constructed outside of the man-proof fence and collecting ditches within the camp area, of a capacity to care for a run-off of 4¾ in. in 1 hour. Sedimentation and storage basins have a capacity for run-off in excess of the filtration rate amounting to from 60 to 80% of Talbot's curve for 24 hours.

Filters.—Three feet selected sand, effective size .25 to .35 mm. Estimated rate, 2½ million gallons per acre per day, without negative head.

Sterlizing Apparatus.—Automatic type for treating filtrate with hypochlorite of calcium, 30% available chlorine, at rate of '25 lb. bleach per million gallons.

Retention Basins.—Capacity for 15 minutes' retention at maximum rate of run-off.

There are no flush closets within any of the above camps. Liquid camp wastes, other than urine, are delivered from inside plumbing fixtures to the drain, which terminates in a sedimentation tank or grease trap, with capacity for about 4 hours' flow from camp population, using about 40 gallons per capita daily. The effluent from this tank is discharged upon the surface of one of the filter beds, which is trenched for this purpose and provided with alternating gate to divert the flow. This filtrate passes through the sterilizing apparatus and retention basin, above described, before discharging into a watercourse. Incinerator plants are located at shafts and portals and along the line of the work, or else portable water-tight receptacles are provided and brought into camp daily for incineration of contents. In some cases it has been considered more effective to sterilize the entire flow of a watercourse rather than to attempt the chlorination of several filtrates entering the same stream. The apparatus employed for this purpose is illustrated in the plates accompanying this paper.

Pocantico Watershed, Supplying North Tarrytown, Ardsley, Hastings, Dobbs' Ferry, Scarsdale, etc., from Pocantico River.—Filtered.—This shed is occupied by portions of Contracts 55 and 62. Precautions have been taken to locate camps off of shed where possible. In other cases similar precautions to those in use on the Croton shed have been applied on a less extensive and elaborate scale. Present force about 200 men.

Saw Mill River Shed.—Supplying Pleasantville and Yonkers.—Filtered.—Occupied by portions of Contracts 52, 55 and 62. Precautions taken: incineration of excrementitious wastes; liquid camp wastes treated in septic tanks, followed by natural or artificial filtration. Substitute water supply to be furnished village of Pleasantville on account of physical interference with existing supply. Present force, about 750.

Bronx Watershed.—Headwaters, supplying Kensico Lake, used by Williamsbridge. Shed occupied by Contracts 9 and 55. Precautions taken to house employees outside of shed; to incinerate all excrementitious wastes produced on work, and to prohibit the general use of animals above the dam by requiring use of traction engines and machinery wherever practicable. Further precaution has been taken to treat the entire supply drawn from Kensico Lake, about 17 to 20 million gallons per day, with hypochlorite of calcium solution under careful laboratory observation. Present force, about 850.

Grassy Sprain Shed.—Supplying City of Yonkers.—Occupied by portions of Contracts 52 and 53. Precautions taken are similar to those on the Croton shed. Present force, small.

This presentation of the subject for technical discussion is the first that has come to the speaker's attention, and for this reason it is hoped that the difficulties of the many problems involved have been sufficiently brought out, as well as the degree of care which has been applied in the attempt to make the means employed practicable and effective.

There can be no doubt that sufficient reason exists why the sanitation of labor camps in general must receive greater attention in the future than it has in the past, and, as evidence of this, legislation has been enacted in England, and is being further studied, looking to governmental supervision in such matters.

Whether statutory legislation on the subject in this State is altogether desirable at this time may be debatable, but it would appear that some power not now available is necessary to regulate the character and extent of certain private enterprises which spring up adjacent to the most carefully regulated and other camps to the great detriment of the contract force and the work being undertaken.

PLATE 35.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

Fig. 1.—Interior of Bunk-House, Contract No 12

Fig. 2. Pan Closet Sanitary, Contract No 45

PLATE 36.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

Fig. 1.—Camp Filters During Construction, Contract No. 23.

Fig. 2.—Camp Filters During Construction, Contract No. 24.

PLATE 37.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
PROVOST ON SANITARY PROBLEMS OF
THE BOARD OF WATER SUPPLY.

FILTERS FOR TREATING EFFLUENT FROM SPOIL BANKS AND CAMPS ON NORTH BANK OF CROTON LAKE, CONTRACT 24.

DISCUSSION.

HENRY W. VOGEL, M. M. E. N. Y.—I am sure I voice the sentiments of the members of the Society when I say we are very grateful to Mr. Provost for his interesting paper this evening.

I believe Dr. Pease and Dr. Flynn co-operated with Mr. Provost in the work of sanitation in the territory occupied by the Board of Water Supply. If they have anything to add to what Mr. Provost has said, we would be very glad to hear from them.

HERBERT D. PEASE.*—Mr. President, I do not know that I have anything to add to Mr. Provost's very interesting and instructive discussion of this subject. There are one or two medical matters which we have taken under special consideration, and one, in particular, which he has not mentioned to-night and that relates directly to the control of diseases which may occur among the men in the camps who come directly from foreign countries, and in that respect, we are following the methods used by Dr. Doty at the Quarantine Station for the State of New York at the Port of New York. That has in the last part of last year consisted in making special examinations of men who could not show that they had been in this country at that time more than thirty days. We are about to revise our ideas somewhat on the control of these men and particularly in relation to the diseases which they import. Cholera is the only disease which they are liable to import for which we have not already made special provisions for prevention.

I do not know that I have anything special to say otherwise, except that this work is intensely interesting. I frequently describe it to those who ask me what the work really consists of—that it is doing everything the Board of Health does in cities of 25 000 to 30 000 inhabitants, the only difference being that the territory is very large, scattered over about 80 miles; and that we do everything except register marriages. We take cognizance of births and of such few deaths as occur.

It is astonishing what a small amount of disease has occurred in these camps. Our chief trouble is from pneumonia and the prevention of that, as you all know, is a matter which is about to engage, and has engaged, the increased attention of health departments in general. Typhoid has hardly existed at all, and only a few cases of chicken-pox and scarlet fever and measles have occurred. Practically nothing else has developed. There were one or two cases of small-pox near the line of the Board's works, but none at all in the camps. We have been fortunate, and yet I think it can be fairly said that some of the preventive measures we have taken have contributed to this success.

* Physician, Lederly Laboratories, 39 West 38th Street, New York.

DAVID S. FLYNN.*—I am afraid that I cannot add to the technical descriptions we have had of the sanitary and medical features of this work, but I do wish to say a few words as to the help we have received from the engineers. I have had the pleasure of talking about the aqueduct in several places, and each time I have said most positively, just as Mr. Provost did a short time ago, that whatever success we have met with, is due largely to the co-operation of the contractors and engineers, but especially to that of the engineers, who, when they found that we were advancing no scientific fads, made our cause their own.

ROBERT RIDGWAY, M. M. E. N. Y.—It is not claimed by anyone who knows about the camps described that they are perfect, but it is claimed that they represent a long step in advance of the camps we have been accustomed to in these parts.

I do not think that Mr. Provost has emphasized one of the important features of the problem he has to deal with; that is, the transient character of the camp population. In the large camp at Browns Station some of the population at least is reasonably permanent, and I understand that a goodly number of the employees have been living there since the beginning of the work, and some will remain until its completion. This is because the job is a long and a big one. On some of the smaller aqueduct contracts, however, especially those on which work is shut down during the winter, the conditions are different, and the force is not as steady. Many of the employees do not remain more than a few weeks, and there is a well-beaten path from the City line to Ashokan made by those who roam from one job to another. Under such circumstances it is not an easy task to educate the floating camp population to appreciate the value of proper sanitary regulations.

Credit for the good results achieved is due to the Board of Water Supply, to the foresight of its Chief Engineer, Mr. J. Waldo Smith, in including the sanitary provisions in the various contracts, and to the vigilance of the sanitary experts, Mr. Provost and his associates, in looking after the camps.

CHARLES E. WELLS, M. M. E. N. Y.—The ground has been very well covered by the paper of the evening. The work of sanitation has been very interesting. There was, at first, some difficulty in securing proper plans for camp buildings and surroundings, the requirements being quite different from those usually in force in construction camps.

The contractors at Hill View have an excellent camp and it has been a bulwark of safety for them in certain investigations instigated by neighboring newspapers during a recent political campaign. Erroneous and misleading reports were circulated about the

---

* Physician, 25 Midland Ave., White Plains, N. Y.

conditions obtaining at the camp, but an official investigation declared the charges not proven.

There is considerable construction work in progress at Hill View Reservoir. The contractor's camp is located near the work and at a convenient distance from the City. The engineers in charge will be pleased to show visitors about the work and camp at any time.

Frank E. Winsor, M. M. E. N. Y.—The Society is to be congratulated on this very able paper by Mr. Provost, which has covered the sanitary control that is being exercised over the camps and construction works along the Catskill water-works system, in a very complete way.

From the standpoint of protection of existing water supplies, the most important drainage areas in which construction is in progress are the Croton and Bronx. The Catskill aqueduct extends through the Croton drainage area for a distance of about nine miles, and there are probably about 1 200 men employed on the construction of the work. In the Bronx drainage area there are some three miles of aqueduct and the construction of the Kensico Reservoir is in progress, upon which there are, or will be, from 1 000 to 2 500 men employed. The fact that the vital statistics show that during the time that work has been in progress there has been practically no typhoid fever, and very little disease of any kind among the contractors' forces, is conclusive evidence of the success of the work being done under the direction of Mr. Provost and Doctors Pease and Flynn. I am pleased to add my testimony to the effectiveness of this sanitary work, and also to state that, as a rule, the contractors have co-operated satisfactorily in carrying out this almost revolutionary work in camp construction and maintenance.

The labor on the work is continually changing, so that there is practically a change in the force every few months; this being in part due to new men coming in, and in part due to the fact that the men drift along the line from one job to another. The new men coming in all have to be educated to the sanitary standards, and it is remarkable how successful this work of education has been. The conditions which are usually found in and about construction camps, due to the absence of any sanitary regulation, are well known and are almost invariably disgraceful. Violations of the sanitary regulations in these camps and works are a decided exception, and it is almost impossible to find any indication of violations either in the camps, along the open-cut work, or in the tunnels.

Special efforts have been made to avoid contamination of the local supplies from tunnel drainage, by providing filters for this drainage and also by dosing with hypochlorite of lime. These precautions are unquestionably justified, although in some cases the

tunnel drainage without treatment has been shown by analysis to be as pure or purer than the local stream into which it discharges.

One of the most effective steps in securing proper sanitary regulation of the camp is the manproof fence which has been built around them. While this does not limit the liberty of the men to go outside of the camp, it materially reduces the probability of breaches of the sanitary regulations.

Another important matter is keeping the quarters for the men properly screened to keep out flies and mosquitoes. The greatest difficulty is in educating the men themselves to appreciate the value of screening. While it is a very important feature of the sanitary work to properly screen the buildings, preventing the introduction and multiplication of flies, good results along this line have so far been attained with difficulty.

Alfred D. Flinn, M. M. E. N. Y.—As I have been listening to Mr. Provost's interesting paper, a remark that our consulting engineer, Mr. John R. Freeman, made four or five years ago came to my mind. He said he thought that this (Board of Water Supply) organization of engineers owed it to the profession to register some distinct and notable advance in the practice of engineering. I think one of the most notable forward steps is the one recorded in Mr. Provost's paper, the safe control of the sanitary features of large construction operations and the humanitarian provisions for the men. This afternoon Mr. D. D. Jackson, of the Department of Water Supply, Gas and Electricity, was at my office and said he thought the fact that 5 000 Catskill aqueduct laborers had been employed now for two years on the Croton watershed without having caused any trouble or even having raised any hue or cry in New York City papers was one of the most notable things done in connection with public works.

Specifications for sanitary works and control were prepared especially for the contracts embracing portions of the Catskill aqueduct in the Croton watershed. They should be printed in the proceedings with Mr. Provost's paper. I quote below:

Sanitary Precautions.

(See Article XXXIII.)

Sanitary Precautions.

Sect. 60. The Contractor and his employees shall prevent nuisances in and about the camps and works; shall protect water-courses, reservoirs, wells and other sources of water supply, public or private, from pollution, contamination or interference; and safe-guard the public health, as may be directed from time to time by the constituted authorities of the State and City. The Contractor shall summarily dismiss and shall not again engage, except with

the written consent of the Engineer, any employee who violates this section.

Inspection by Engineer—Compliance with Sanitary Regulations.

SECT. 61. The Engineer shall have the right, in order to determine whether the requirements of this contract as to sanitary matters are being complied with, to enter and inspect any camp or building or any part of the works, and to cause any employee to be examined physically or medically or to be vaccinated or otherwise treated; also to inspect the drinking water and food supplied to the employees. The sanitary precautions, the care of the employees, the camps and all territory occupied by the Contractor, shall at all times be satisfactory to the Engineer. The Contractor shall promptly and fully, and in every particular, comply with all orders and regulations in regard to these matters, including all sanitary and medical rules and regulations which may have been or may be promulgated from time to time. And to this end and to properly preserve the peace, the Board of Water Supply Police shall have the right of access to the Contractor's camps and quarters.

Quarters and Stables.

SECT 63. Buildings for the sanitary necessities of all persons, buildings for the housing, feeding and sanitary necessities of the men and suitable stabling for the animals employed upon the work. All buildings for these or kindred purposes shall be built only in accordance with approved drawings and specifications at designated places. All houses occupied by employees shall be thoroughly screened to exclude mosquitoes and flies. The quarters for the men shall be grouped in properly arranged camps. Camps shall, if ordered, be enclosed by satisfactory manproof fences with not more than two entrances. Each camp and the grounds surrounding it in all directions shall be thoroughly illuminated by electric arc lamps or other acceptable lights. This illumination shall be maintained from sundown to sunrise every night during the occupation of the camp, unless otherwise ordered. Employees may, so far as practicable, be required to remain within camp when not at work.

Sanitary Conveniences and Disposal of Excreta—Attendants—Preventing Nuisances.

SECT. 63. Buildings for the sanitary necessities of all persons employed on the work, beginning with the first men employed to build camps or other preliminary operations, shall be constructed and maintained by the Contractor in the number, manner and places ordered. All persons connected with the works shall be obliged to use these conveniences, under penalty of discharge. Unless otherwise directed, the sanitaries shall be provided with water-tight removable receptacles of suitable capacity. These receptacles, if used, shall not be allowed to overflow, but shall be removed, without spilling, at required intervals, their contents at

once treated as directed, and then promptly taken to a designated place outside the watershed, and there disposed of as ordered. If incinerators be used, they shall be efficiently operated. The Contractor shall provide a sufficient number of acceptable attendants to keep all sanitaries in satisfactory condition and compel employees to use them. The Contractor shall rigorously prohibit the committing of nuisances, within the tunnels, the aqueduct, or other completed or partially completed structure, or upon the lands of the City, about the works or upon adjacent private property.

Medical and Surgical Attendance—Hospitals.

SECT. 64. The Contractor shall retain the services of acceptable qualified medical and surgical practitioners, to the number ordered, who shall have the care of his employees, shall inspect their dwellings, the stables and the sanitaries as often as required, and shall supply medical attendance and medicine to the employees whenever needed. The Contractor shall provide, from approved plans, one or more buildings, properly fitted for the purposes of a hospital, with facilities for heating and ventilating in cold weather, and for screening and ventilating in warm weather. These hospitals shall have an ample number of beds to properly care for sick or injured employees, and shall be provided with all articles necessary for giving "First Aid to the Injured," as well as with all necessary medicines and medical appliances for the proper care of the sick and injured. Another building of approved design shall be provided and equipped as an isolation hospital, and any employees who shall be found to have a communicable disease, shall be at once removed from the camp to this hospital, and there isolated and treated as directed. Whenever practicable, an employee having a communicable disease shall be removed when and as directed to a hospital outside the watershed.

Medical Supervision of Employees.

SECT. 65. The medical supervision of the Contractor over his employees shall extend to the physical and medical examination of all applicants for employment, in order to prevent persons having communicable diseases from becoming connected with the work, and the Contractor shall employ only persons shown by such examinations to be free from communicable diseases. Whenever, in the opinion of the Engineer, it is necessary for the protection of the public health or the health of the employees, the Contractor shall remove any employee from the work either to a hospital at or near the works or to a more remote hospital, or shall remove permanently from the work or any camp any employee whose presence is believed to endanger the health of other persons.

Health Reports.

SECT. 66. Once each week, or more frequently, if required, the Contractor shall give the Engineer, in such detail as may be prescribed from time to time, a written report, signed by a physician in regular attendance, setting forth clearly the health conditions

of the camp or camps and of the employees. If any case of communicable disease be discovered or any case of doubtful diagnosis, it shall be reported at once to the Engineer, by telephone or messenger, and confirmed in writing.

Domestic Water-Supply—Bath and Laundry Facilities.

SECT. 67. The water furnished by the Contractor shall include a sufficient supply of drinking water of acceptable quality for all his employees, to be obtained from approved sources. He shall provide ample bathing and clothes-washing facilities for his employees and sufficient water of acceptable quality therefor. If any water-supply for domestic uses should become contaminated, the Contractor shall promptly provide a new supply from an approved source and abandon the contaminated supply, or shall provide works for purifying the contaminated water, when and as ordered.

Disposal of Wash Water and Stable Drainage.

SECT. 68. All wash water from kitchens, laundries, and other places, and all drainage from stables, shall be conveyed by satisfactory means to places directed, where such drainage shall be treated by the means ordered so as to yield an acceptably innocuous effluent.

Drainage from Camps and Tunnels to be Filtered.

SECT. 69. Drainage from camps and tunnels and from other places yielding water unfit for direct discharge into a reservoir or tributary thereof shall be conducted in tight drains or other approved conveyors to filters, septic tanks or other disposal plants of approved construction, at places designated, and treated as directed to produce an acceptable effluent. Such effluent shall be discharged only in the manner and at the place or places directed.

Garbage Disposal.

SECT. 70. Garbage, both liquid and solid, shall be promptly and satisfactorily removed from the buildings and immediately placed in approved tight receptacles of sufficient capacity for about one day's ordinary production. At least once in every twenty-four hours all such garbage shall be incinerated or otherwise thoroughly and satisfactorily disposed of in an approved manner.

Contractor to Build Sanitary Works.

SECT. 71. The Contractor shall build, in accordance with drawings and directions furnished from time to time by the Engineer, such disposal plants, sewers, drains and other structures, and shall do such other work, not herein particularly specified, as may be ordered for carrying out the intent of the sanitary precautions of the contract.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 65.
PRESENTED MAY 24TH, 1911.

CONSTRUCTION OF THE RONDOUT PRESSURE TUNNEL OF THE CATSKILL AQUEDUCT.

BY LAZARUS WHITE,* M. M. E. N. Y.

WITH DISCUSSION BY
JOHN P. HOGAN, ROBERT RIDGWAY, HENRY W. VOGEL, THOMAS C. ATWOOD, HERBERT M. HALE, CHARLES GOODMAN, AND LAZARUS WHITE.

New York engineers can well claim the honor of having first used deep tunnels in rock to carry aqueducts below streams or depressions, such construction being known as "siphons" or pressure tunnels.

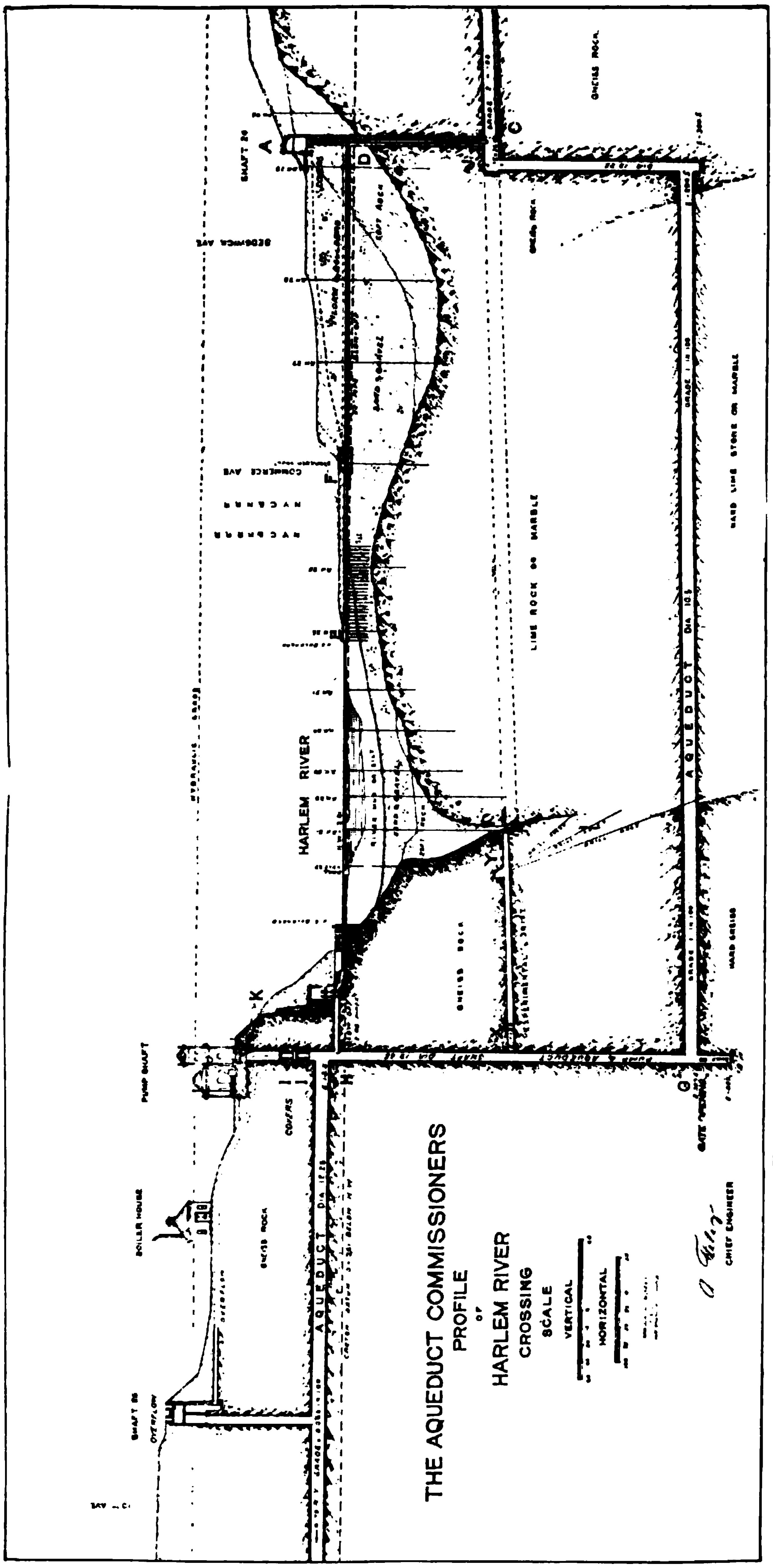
The New Croton Aqueduct, a tunnel mostly at grade, about 30 miles long, was a great work, but the boldest and most original portion of it is the then unprecedented stretch known as the Harlem River siphon, a tunnel 7 miles long, depressed about 400 ft. below hydraulic grade at the Harlem River. This has been in continuous operation over 20 years, giving no trouble whatever, and with slight leakage, and has already outlasted steel pipe lines, the alternative construction, laid even later.

It was fitting, then, that in the construction of the Catskill Aqueduct the siphon or pressure tunnel should be used in many instances and on a very large scale. Mr. Wiggin, in his paper† of October 27, 1909, submitted to this Society, went very fully into the design of pressure tunnels and gave much information about

* Division Engineer, Board of Water Supply.

† Paper No. 51, "The Design of Pressure Tunnels of the Catskill Aqueduct," by Thomas H. Wiggin, M. M. E. N. Y.

PLATE 38.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.



Profile of the Harlem River Siphon, the First Deep Pressure Tunnel.

the Rondout Siphon. Mr. Robert Ridgway, M. M. E. N. Y., and Past President of this Society, has stated that while the Hudson River siphon was the most spectacular, the Rondout Siphon, in his opinion, was the boldest piece of work attempted in the Catskill Aqueduct, due to the variety of strata encountered and the difficulty of shafting and tunneling in some of them. This, then, is the justification of this paper.

The Catskill Aqueduct will furnish water to New York at a high level, its flow line at its source being Elevation 500 above mean sea level. It discharges into Hill View Reservoir at the northerly line of New York City at Elevation 300. The Croton Aqueduct fills Central Park Reservoir at an elevation of only 115 ft.

The Catskill Aqueduct follows the contour of the ground where suitable support is found, and is then of the cut-and-cover type. But many valleys have to be crossed and divides pierced. For the latter construction, grade tunnels are used, and for the former, steel pipe or deep pressure tunnels. Steel pipes are used to cross small streams and some valleys where the rock conditions were found to be bad. The first two valleys below the Ashokan Dam are crossed with steel pipe, the third, that of Rondout Creek, with a deep pressure tunnel about 4½ miles long.

It would be hard to find, except in mining work, another instance where the geology of a region has been of such importance as in the location of the Rondout Siphon. In the Rondout Valley are many rocks differing widely in character and varying from the hardest millstones to the softest shales. These rocks, all sedimentary and originally deposited in level beds, are now tilted up at various angles and folded and faulted in a complex way, but still capable of being correctly interpreted from outcrops and borings. In addition, the rocks and depressions are buried under a deep mantle of glacial drift. In fact, two glacial gorges were believed to be present.

Some of the best geologists were engaged to examine the locality, and from outcrops and other data a profile was worked up. This proved to be of great aid in subsequent investigations, but was qualitative rather than quantitative. It gave us a good idea of what to look for, but no definite location could be made, as the thickness of the various strata and the depths of the buried gorges had to

be worked out by diamond drill borings. Finally the profile shown on Plate 33, of Paper No. 51, by Mr. Wiggin, was developed and confidently believed to be nearly correct. The borings took a great deal of time and were expensive, but the resultant certainty of location and foreknowledge of conditions to be met amply repaid the expense and time. In a deep tunnel of this character, it is considered absolutely necessary to keep the tunnel in solid rock and not let it penetrate the drift of filled-in gorges. A depth of at least 150 ft. below the lowest point of these gorges was considered safe. The Loetschburg Tunnel illustrates well the enormous cost and disastrous result of running into a gorge. The Kandar River was to be passed at a safe depth in solid rock, but an estimate of geologists based only on superficial evidence was used, no borings being taken. When about 600 ft. below the river, soft, water-bearing drift was struck, which quickly overwhelmed 25 men, filled up the tunnel and caused the abandonment of over one mile of it. Subsequent borings showed that the gorge extended far below tunnel grade, and that this fact could have been very easily determined in advance. It speaks volumes for the thoroughness of the Board of Water Supply work when we consider that despite the many streams which have been passed, no disagreeable surprises of this nature have yet occurred.

To show the difference between our knowledge of the rocks of the Rondout Valley and the growth of this knowledge with the progress in boring, the data shown on Plate 40 were prepared, reproducing the various interpretations of the stratifications as the boring work progressed. It will readily be seen how imperfect the original information was and how the complicated folding or faulting had to be introduced to correctly interpret the borings. In particular it will be noted that the two preglacial gorges reversed the assumed depths, the deeper one being near Shaft No. 4, instead of between No. 1 and No. 2, as originally supposed. The tunnel showed the stratifications only slightly different from that given in the contract profile.

To make clear for future reference the various rocks met with in the Rondout Siphon a description of each stratum shown on the profile is here given:

The Hudson River shale is of unknown thickness, probably

PLATE 39.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

Fig. 2.—Spouting Hole in Schawangunk Grit, Near Shaft No. 7.

Fig 1.—Sullivan Hydraulic Diamond Drill in Operation on Esopus Siphon

several thousand feet. It is a thinly bedded, black, slaty rock, containing in places sandy layers. These sandy layers are massive beds in places, but in the Rondout Valley are relatively insignificant. The Hudson River shales belong to the Upper Silurian, and represent a vast period of time before the other rocks were laid down. They were then folded and faulted in a very complex way. They are usually a very tight rock, hard and almost dry, and contain considerable calcareous matter, which has healed and completely filled very numerous old fractures. It is quite hard when first quarried, but soon weathers and breaks down to clay.

The Shawangunk grit, or millstone, about 250 ft. thick, is a conglomerate composed of quartz pebbles cemented with silica, thus forming a massive rock of almost pure quartz. It is laid upon the Hudson River shale non-conformably, and contains a few green shale bands. Due to its hardness and purity it is the most conspicuous rock in the valley, and has had a large bearing on the location of shafts and siphons. It has been quarried to a considerable extent for millstones and used in a few buildings. Its color is usually pure white, but in some places has a rosy tint. The pebbles are only about ¼ in. in diameter.

The High Falls shale is conformably laid upon the grit. It is a thin series of soft shales, alternating green and red bands, with one layer of sandstone included. Some of the green layers are calcareous, with a large part of the calcareous matter dissolved out so as to render them porous.

The Binnewater sandstone is an extremely variable rock, varying from a hard quartzite to a soft, crumbly sandstone. It also contains honeycombed layers resembling furnace slag. These layers have been found to be water-bearing. Withal, this is the most dangerous rock for both shafting and tunneling.

The Helderberg limestone (here classed as one) is separated by geologists into five large divisions and several smaller ones. The bottom stratum is the cement rock formerly extensively used in the manufacture of Rosendale cement. It is hard, black, and closely crystalline. The Coeymans, overlying the cement rock, is a closely crystalline limestone about 75 ft. thick. It is the first layer of the Devonic Era. Above it is the New Scotland, a rather shaly limestone, which in turn is overlaid by the Becraft, of a fine crystalline

and highly fossiliferous nature. The upper layer, the Port Ewen, is more or less shaly, but in common with most of these limestones contains flinty bands.

Next in the series is the Esopus shale, a deposit several hundred feet thick, which is penetrated by about a mile of tunnel. It is a rather gritty shale, very good for shafting but in the main treacherous for tunneling. It is without distinct bedding, is full of incipient cracks in different planes, and has also a conchoidal cleavage. It disintegrates very readily into small cubical pieces, but is very slow to completely slake.

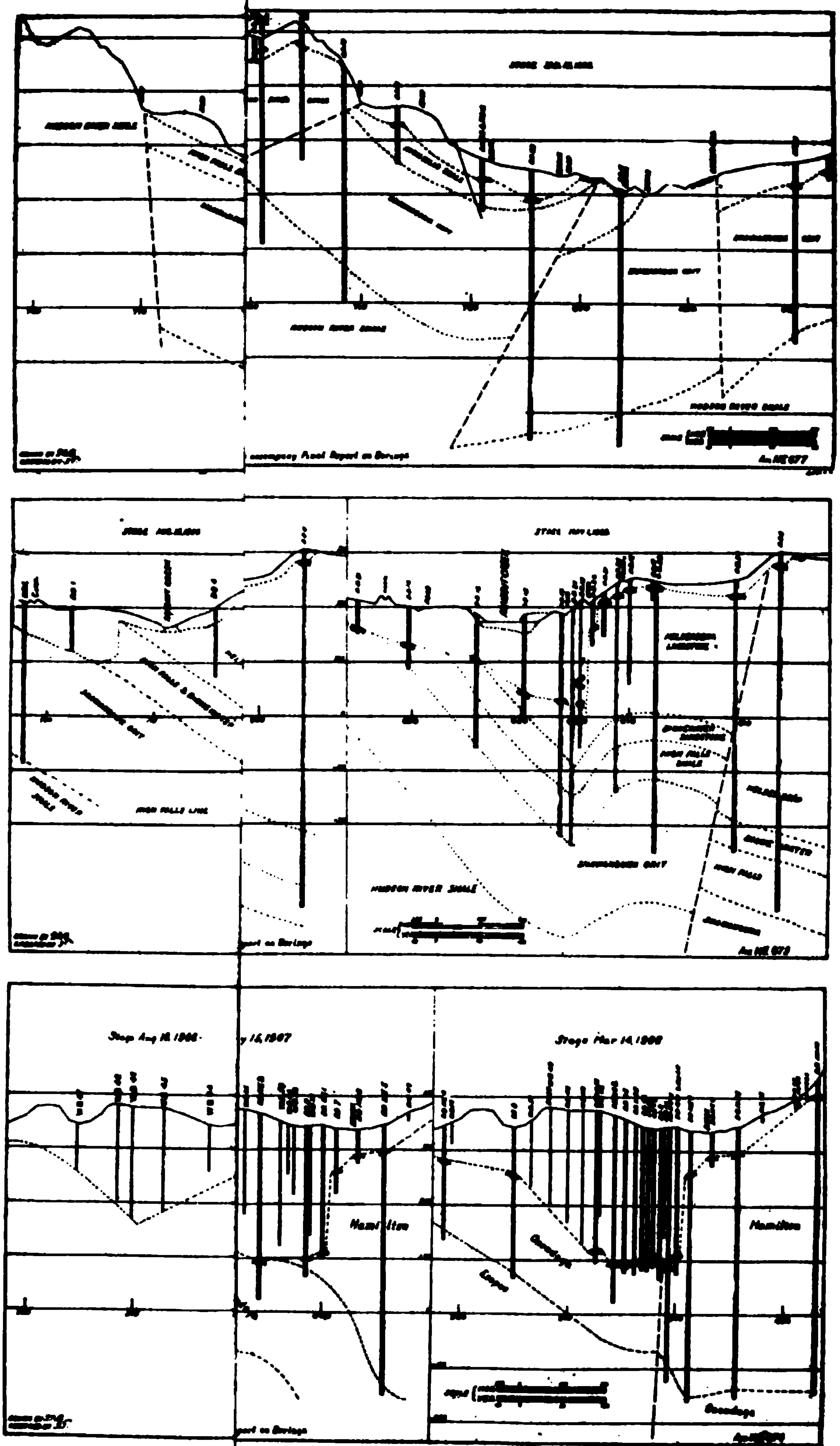
Overlying the Esopus shale, and gradually blending into it, is the Onondaga limestone, a hard, bluish-white rock containing considerable flint. It is only about 100 ft. thick and not very important.

The Marcellus shale is a black, rather soft shale, in very thin layers, and overlies the Onondaga. It is a fine rock for shafting but rather weak for tunneling. Overlying it is the Hamilton shale, a harder rock with more massive beds, but still quite soft and free drilling. Both the Hamilton and the Marcellus shales are very tight and dry and very good for shafting. These black layers, when slickensided by movement, have a strong resemblance to anthracite coal and in some places have been distilled for coal oil.

Nearly all the rocks of the above series are fossiliferous, and have been subdivided by means of their characteristic fossils. Although these rocks have been extensively studied in the cement mines and quarries only a few miles away, they differ extremely from the type beds. For instance, at Binnewater the Shawangunk grit is a thin bed less than 100 ft. thick, and the High Falls shale and Binnewater sandstone are also thin and insignificant. One rock is entirely lacking, the Oriskany sandstone, which is found in other places between the Helderberg limestone and the Esopus shale. The Esopus shale in other places seems to be quite a hard rock, but here is described as relatively soft.

The lesson to be learned from the above is that detailed knowledge of any particular location is necessary for engineering structures, and that generalizations from previous knowledge and studies are dangerous guides, particularly when the rocks have been studied in distant places, even though they are so-called type localities. It has been shown here that studies made before this work at places

PLATE 40.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.



) OUT BY BORINGS

only a few miles away furnished very misleading conclusions when applied to the neighborhood of the Rondout Siphon. Also that little reliance is to be placed on plausible descriptions of geologists unless based on exact knowledge obtained in the location of the work in question.

During the boring operations many tentative profiles were drawn up for the purpose of locating new holes. One after the other they had to be modified from a simple profile originally assumed to the rather complex one finally adopted. Had the siphon been located from any but the final assumed section, many unexpected difficulties would have been found in shaft-sinking and tunnel-driving, which might have had the effect of seriously delaying the work and increasing the expense of construction. No conditions have been found in either shafts or tunnels which differ materially from those expected.

Reference to Plate 40 reveals the following salient features: Two buried river gorges, one at Rondout Creek reaching sea level, the other, below Shaft 1, at Elevation +100; also the bed of Shawangunk grit reaching Elevation —250 near Shaft 7, and several well-determined faults. Due to the great head of water on the walls of the tunnel at Rondout Creek (an unbalanced pressure of 300 ft.) it was decided not to allow any portion of the tunnel to approach closer than 200 ft. of the low points in the rock profile. It was also decided to avoid the Shawangunk grit as much as possible, due to the expense of driving through this very hard rock and the danger from leakage through open seams and fractures in this bed. Consequently, north of Rondout Creek the tunnel was placed at —100 ft. elevation, and south at —250. The next problem was to locate the shafts. Shafts Nos. 1 and 8 are the downtake and uptake shafts respectively, and are so located as to give the shortest siphon across the Rondout Valley consistent with a good location of the aqueduct north and south. Shaft 8 was originally intended to be placed near diamond drill hole 19/17, but a bad condition of rock was revealed there by the borings, and it was placed further back to avoid the bed of grit as much as possible.

After considerable investigation, rates of progress for tunnel-driving and shaft-sinking in the various rocks were assumed, and the shafts located so as to give the time to finish this contract in

about 54 months, or in about the time that a portion of the Ashokan Reservoir will be available. Eight shafts as located gave the required results. The assumed rates are as follows:

Shale Tunnel	120	ft. per month
Grit "	60	" " "
Shale Shaft	40	" " "
Grit "	20	" " "

As very little was known about the drilling and tunneling qualities of Shawangunk grit, as compared with ordinary rocks, two experimental tunnels were driven near Shaft No. 8, one in Hudson River shale and one in Shawangunk grit. Due to a fault both these rocks lay side by side and the tunnels were driven by means of one steam plant. Although only 100 ft. of tunnel was driven in each rock, valuable results were obtained, as skilled tunnel men were readily obtained by the contractor, Naughton & Co., from the neighboring Rosendale cement mines. At the expenditure of only a few thousand dollars, information was obtained which materially aided in the location of the tunnel. The conclusions reached have been amply borne out by the work in the Rondout Siphon.

The rates of progress of driving shafts and tunnels were assumed at a safe figure, which it was supposed any good contractor could make, but it was also thought that with very good organization and with skilled men, much better speed could be made. This has been the case, as will be shown further on. The T. A. Gillespie Co., to whom the contract was let in June, 1908, have with their very efficient plant and organization obtained much greater speed than those originally assumed.

It has been urged upon the writer that there is very little to be found from the civil engineer's standpoint on the subject of shaft-sinking, and that a description of the methods used on the Rondout Siphon shafts, with some reference to the lessons to be learned from them, will be of considerable value to the profession. The shafts there sunk are of unusual depths for public work, and such a variety of conditions were encountered that a mere description of how they were met cannot fail to be of value. In addition, the writer believes that more and more deep tunnels will be used for aqueduct and other purposes in place of pipes. Tunnels have

PLATE 41.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

FORMS AND STEEL SHOE FOR BOTTOM OF REINFORCED CONCRETE CAISSON AT SHAFT NO. 2.

the great advantage of durability and low maintenance cost, and even if much higher in first cost, will eventually cost less and be much more satisfactory than perishable metal pipes. The great bugaboo of this kind of work has been the deep shafts necessary. All civil engineers have approached them with a good deal of timidity. It is hoped that the experience on the work described may be of value in enabling engineers to appreciate deep tunnels at more nearly their proper value. The writer is aware that mining engineers are acquainted with shaft-sinking. The conditions in mining districts are very different from those on ordinary contract work which the civil engineer has to deal with; and we do not have the incentive of a body of valuable ore which may even pay for the cost of the shaft while it is being sunk.

SHAFT IN EARTH.

The overburden at the shafts varied from a few feet to 83 ft. In all but three places, it was a stiff boulder clay or hardpan. All the construction shafts but one were sunk with the aid of ordinary timbering sets and lagging of the general type shown on Plate 43.

At three shafts, circular concrete caissons were sunk to rock; at Shafts No. 1 and No. 5 as permanent shaft lining and at Shaft No. 2, because it was found impossible to get the timbering down. Shaft No. 1 could have been easily sunk to rock with timbering, but as the specifications called for all timbering to be removed to the level of ground water before placing a permanent lining, it was decided to use an open concrete caisson.

To the depth of the siphon chamber, ordinary timbering was used, as this could readily be removed. Twenty-three feet below ground, a steel riveted shoe was placed and concrete forms placed over it. At first by means of the interesting forms shown on Plate 41, 25 ft. of caisson was cast. Then the center was excavated with pick and shovel and earth removed with a derrick. Gradually the caisson sank and new sections were added on top. At the beginning it sank plumb, but after a depth of 26 ft. it started to lean. This was partly remedied by digging under the high side more than under the other. No particular difficulty was met until a depth of 34 feet was reached, when the friction on the sides became so great that the enormous weight of the caisson was insufficient to over-

come it even though the cutting edges were undermined. The contractor was forbidden to soften up the sides with water or air, as proposed, for it was feared that this would cause settlement of the surface, upon which a heavy siphon chamber was to be founded. A moderate amount of water was allowed to be placed through grout holes in the concrete caisson, but finally it was necessary to load down the caisson with a box containing about 250 tons of earth.

Nevertheless, a depth of 63 feet was reached, as originally planned, but it was found that ledge was even deeper, the indicated rock being a flat boulder. As the material was a remarkably stiff, dry and uniform boulder clay, the earth below the caisson was excavated to the required shape 20 ft. to rock. An inside form was placed and concrete deposited between it and earth. This practically founded the caisson on rock. Through grout holes on the sides, the space between the caisson and the earth was grouted. It is not believed that any settlement of the earth surrounding the caisson occurred.

As the material penetrated was absolutely uniform, dry, and stiff boulder clay, a less expensive method might have been used. It was almost too much to expect that such favorable conditions could exist, as in such material sand and clay streaks often occur, such strata being very hard to detect in borings. The enormous friction that opposes the sinking of the concrete caisson in stiff ground, is especially to be noted. This may develop at the top of the caisson in such a manner as to leave practically all its weight suspended from one of the upper joints. This makes it necessary to have the successive sections well tied together by vertical rods. Such ties were placed at Shaft No. 1, but the neglect of this precaution at Shaft No. 5 led to almost disastrous results. It would appear from the experience of Shaft No. 1 that an open concrete caisson can hardly be sunk more than 50 or 60 ft. through stiff material with excessive friction on the sides. That is, when gravity alone is relied upon and it is not allowable to soften up the sides.

At Shaft No. 2, the method of Shaft No. 1 was tried, but as this was only to be a construction shaft no restrictions were placed by the engineers, provided certain size cageways could be secured. The material to be penetrated is supposed to have been deposited in the bottom of a glacial lake formed by the damming

PLATE 42.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

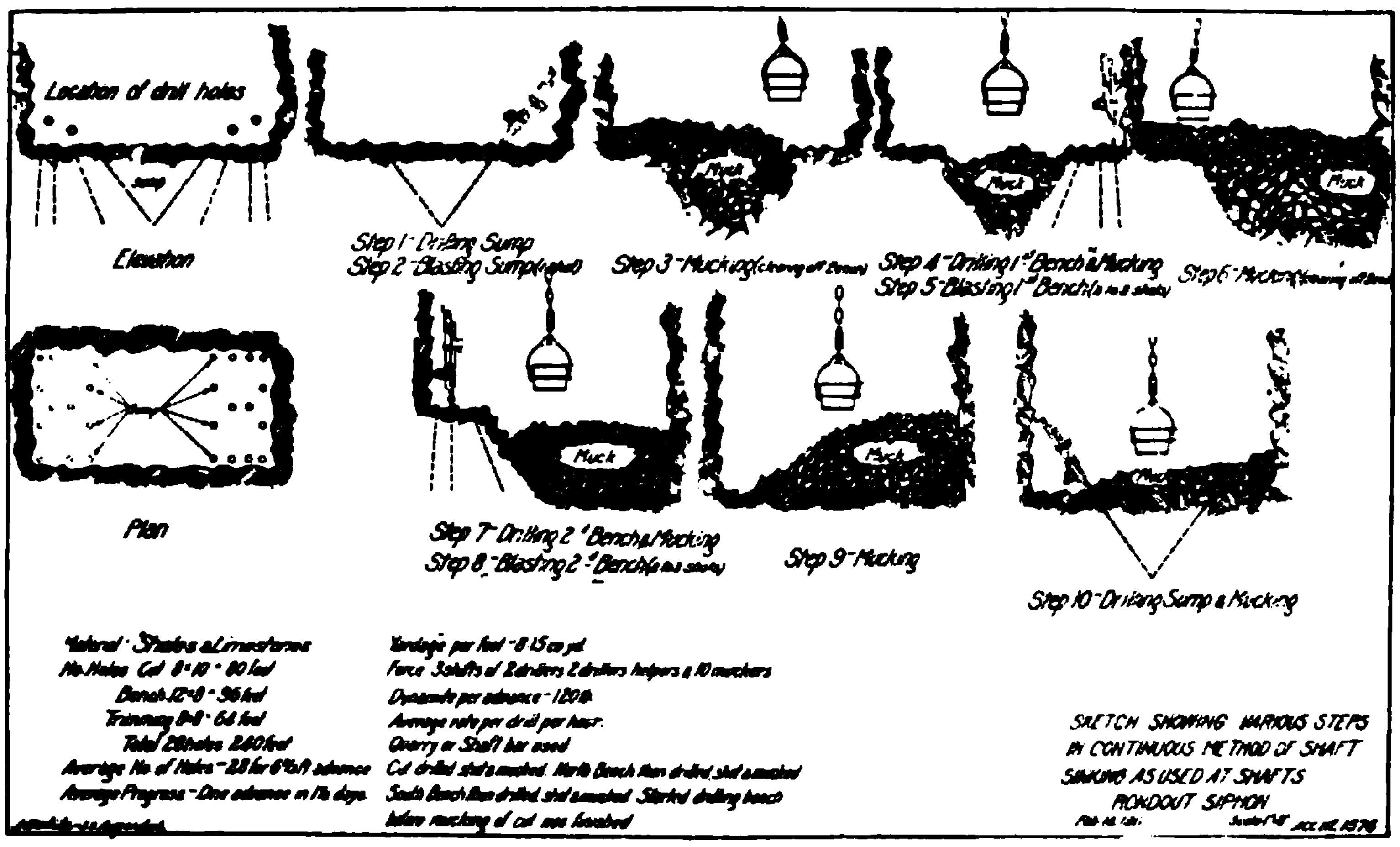


FIG. 1.—METHOD OF SINKING RECTANGULAR SHAFTS, RONDOUT SIPHON.

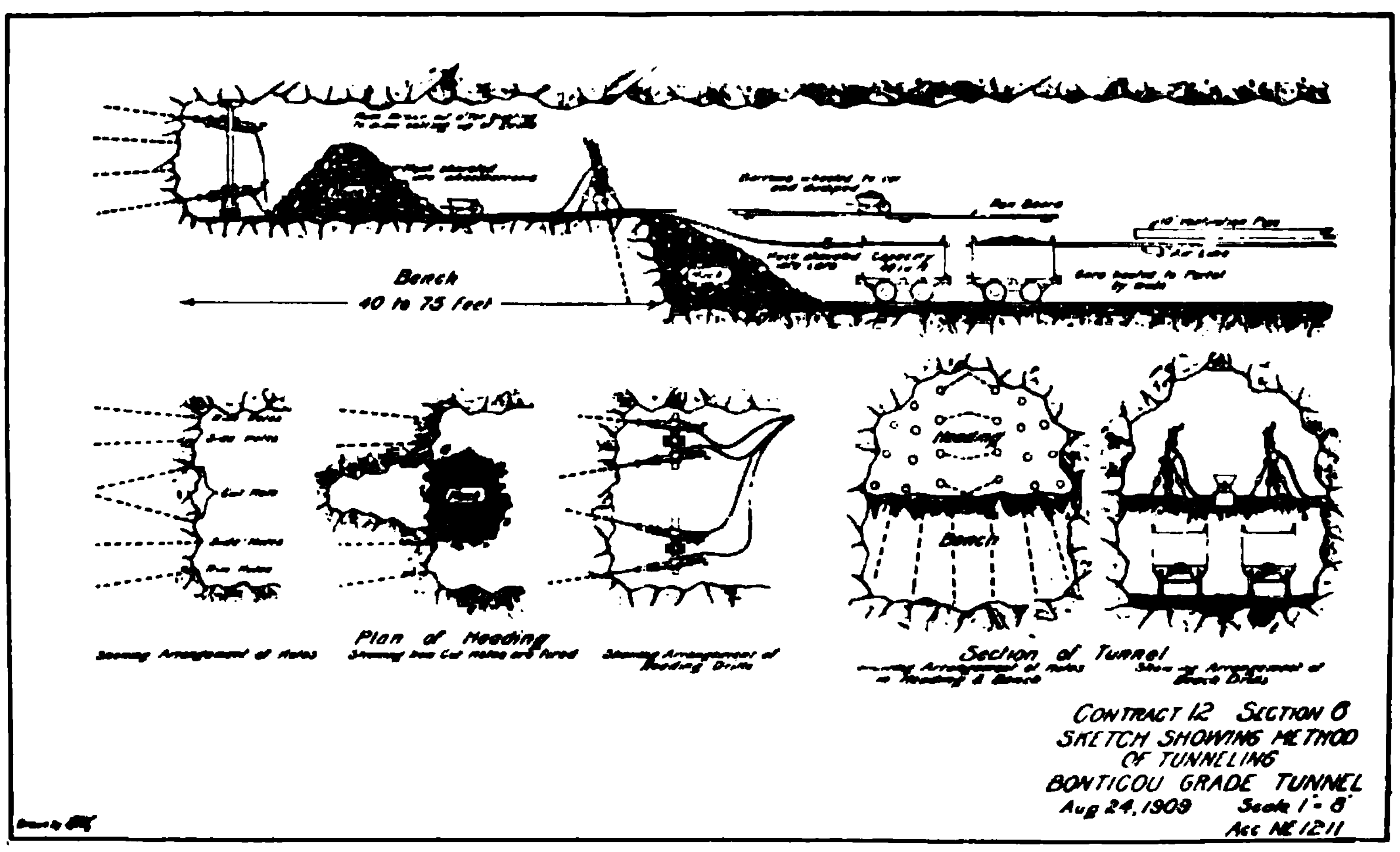


FIG. 2.—METHOD OF EXCAVATING GRADE TUNNEL.

up of an old stream by the advancing ice. This material is a very fine sand and clay, such as is carried by streams under glaciers and known as glacial milk. Near the bottom, the material which may properly be called quicksand has large limestone boulders deposited in it. This gives a rare combination of very fine and soft material with large boulders. The boulders, if we allow ourselves to speculate, may have been carried out into the lake by ice and dropped into its soft bottom. An abortive attempt was made to get down with ordinary wooden sheeting and bracing, but only a very few feet could be penetrated. Next, a few feet below the surface, a steel shoe was built in place (see Plate 41), and sections of concrete built on it. The material proved hard to dig. It was difficult for a man to stand in it and excavate with a shovel, so it proved necessary to shovel from floating boards. The caisson sank, however, very nicely and evenly, care being taken not to dig below the shoe. A feeling of confidence was given by this and when the material was supposedly better, the shoe was undermined, being then 19 ft. below the surface of the ground. Suddenly the caisson started to drop and then appeared to take a plunge out of sight. Several men working on the bottom felt themselves raised with it. Fortunately, the caisson after dropping 7½ ft. in 35 seconds, stopped with the top of the concrete level with the soft, oozy material. Had it sunk a few feet more, it would have filled up. The caisson was at the time in a very fine, sandy material, thoroughly saturated with water, but allowing no water to flow through it. It would assume a very flat slope on being dumped, about 1 vertical to 100 horizontal. After waiting a few days, the material gripped the sides of the caisson like mud does a pile, and new sections were built up and sinking resumed. The cutting edge could not be reached until the boulders near the bottom were struck, because the level of the soft material in the caisson always remained a few feet above the cutting edge. Thereafter, a great deal of material flowed under the cutting edge from without and large settlements took place. In addition, the caisson started to wobble and appeared to float around in the ooze like a huge cork, although weighing hundreds of tons. The derrick for excavating had to be moved back to reach solid ground.

When the boulders in the soft ground were struck, the caisson was several feet out of plumb and sinking was very difficult. The

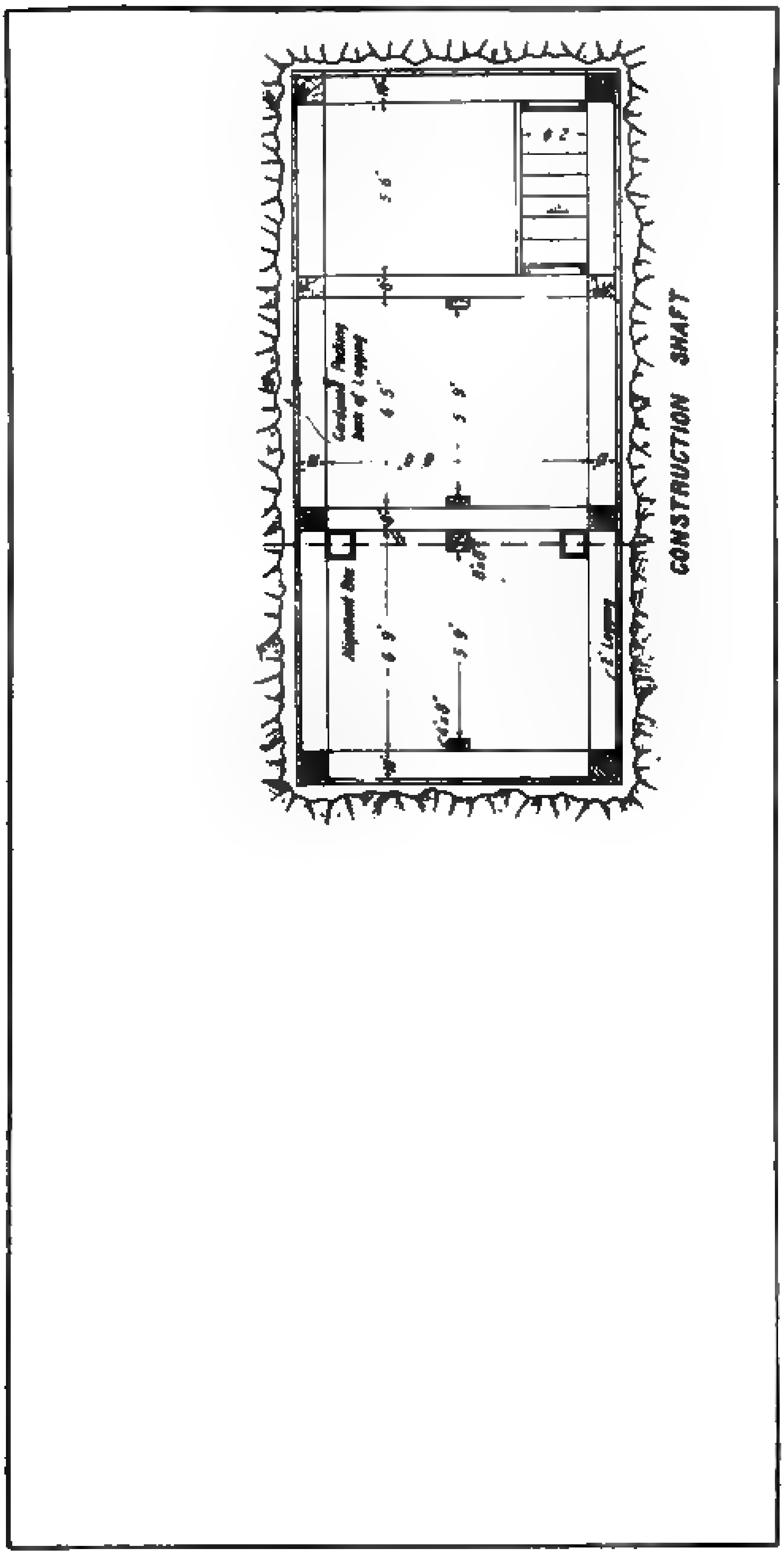
boulders were blasted away, and a platform erected on top of the caisson and loaded with great quantities of earth to right it. In addition, to facilitate sinking, compressed air was blown through grout pipes in the concrete shell. This helped very much. The air would escape in little craters, in some cases several feet away from the caisson. Finally rock was reached and the caisson was 1½ ft. out of plumb and its center of gravity shifted 1.1 ft. from its original position. At times it was several feet out of plumb in different directions.

Considering the ground penetrated, the method was about the only one that could be used with much promise of success. After a little cutting of the caisson, room was obtained for the cages, and the caisson has served its purpose admirably ever since, keeping out all water, etc. It would appear that it was rather risky to leave a caisson of this description entirely open. A deck about ten feet from the cutting edge would be advisable with openings in which air locks could be placed if necessary to use compressed air.

Shaft No. 5 in Earth.

The surface material here was found by borings to be about 50 ft. in depth. At first, the boring men reported sand and gravel, and samples preserved in bottles were certainly of this material. As the rock surface here is considerably below the adjacent surface of Rondout Creek, it appeared to be a serious matter to reach rock. It was known, however, that wash samples are prone, when penetrating hard material, to wash away the clay, leaving a residuum of sand and gravel. A test pit sunk to a depth of 15 ft. showed a compact hardpan composed of clay, sand, gravel and boulders. It was then thought that this material extended to the rock. Nevertheless, it still remained to be careful, as hardpan often contains water-bearing layers of sand and gravel which would be hard to distinguish in the borings. The contractor's engineer proposed to sink a drop shaft to rock, that is, an open concrete caisson, about 16 ft. in the clear and 2 ft. thick, reinforced as required by horizontal bars. The requirements of this shaft were very rigid, as it was necessary to sink the shaft nearly plumb on account of the discharge pipes, etc., for the drainage system, also that no ground should be lost or no settlement of the surface, due to the necessity of founding

PLATE 43.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.



Cross Section of Rectangular and Circular Shafts, with Timbering as Constructed, Rondout Siphon

a large drainage chamber in the earth at the top of the shaft, it being very expensive or impracticable to carry the foundations of the chamber down to rock.

The contractor gave assurances that the disadvantages of this type of shaft would be overcome and a caisson could be sunk plumb and cause no settlement of the surrounding ground. It was to be kept plumb by wooden guides placed in the open timbered portion. At each joint sufficient rods were to be placed to support one-half the weight of the caisson below.

With this assurance, the contractor was allowed to proceed. A very strong steel shoe was constructed at the bottom of the timbered excavation, about 12 ft. below the original ground level. This shoe was tied to the concrete above by steel bars. About 20 ft. of concrete was first placed above the shoe, using wooden interior and exterior forms. Timber guides were placed outside of the caisson and supported by wales of the timbered portion above the cutting edge. The sinking continued smoothly for ten days until a depth of 32 ft. was reached, at which time the caisson was buried 20 ft. in a very hard, dry, hardpan or boulder till. At this point, the friction became so great that it ceased to sink, even when the cutting edge was entirely undermined. At this time, the caisson was 3 in. out of plumb. The outside of the caisson was lubricated with water and rakers were placed inside to right it. It was then lowered a little and straightened up until it was only 1 in. out of plumb.

The caisson then stuck very stubbornly and refused to go, even when loaded with 100 tons of stone, its sides lubricated and its interior flooded. Before flooding, a test pit was dug in the center in an effort to reach rock, but about 20 ft. below the cutting edge, a bed of boulders was struck and above this several feet of stratified clay. In their eagerness to get down, the contractors undermined the cutting edge several feet, and took out a lot of material in the center. In desperation, and without permission, they set off several sticks of dynamite in the water which was allowed to fill the interior after the portion below the cutting edge was securely braced. To their delight, the caisson settled 3½ ft. in a very short time. This was one week after the caisson first stuck. The concussion must have strained the cylinder, however, because the following day, when everything was going smoothly, it broke in two, the

cutting edge burying itself 2½ ft. in the soft clay below. Upon examination, the two sections which parted company were found to be exactly in line, the upper part bound fast in the boulder clay and refusing to follow the lower part. It was also found that through an oversight only one-third of the required number of vertical rods were placed, only the number specified for the lowest joint being used. The two sections were then bound together by cables, holes bored in the upper and lower portions, twisted rods inserted and the gap, which had increased to 3½ ft., concreted. While the concrete was soft, the upper part was loosened by poking rods along the sides, and it settled onto the lower portion. It appeared that some boulder or boulders, wedged against the upper portion of concrete, bound it fast. The lower portion being free and practically suspended, threw its whole weight on a weak joint, and settled quickly into the clay below. A few days after the two portions were reunited, rock was reached at a depth of 50 ft., the caisson then being only 1½ in. out of plumb. The lessons to be learned from the experience at Shafts No. 1, No. 2, and Shaft No. 5, are as follows:

1.—Drop shafts or open caissons are only good in stiff materials or even in soft materials for about 50 ft., although by telescoping greater depths can be reached.

2.—Caissons should be very strongly tied together vertically, each joint being strong enough to carry the whole weight of the part below.

3.—Caissons should be started plumb and guided well for the first 15 or 20 ft.

4.—In very soft ground, a deck should be provided a few feet above the cutting edge, so that it can be turned into an air chamber and a moderate pressure of compressed air used.

5.—A good strong cutting edge, securely tied to the concrete above is a great advantage.

6.—Caissons require great watchfulness and care in sinking, but once down, are admirable tops of shafts in any material, and when sunk without mishap are neither expensive nor slow.

Shafts No. 3, No. 4, No. 6, No. 7 and No. 8 in Earth.

Shafts No. 3 and No. 4 had to go only a few feet to reach ledge rock and ordinary timbering sufficed. The grit ledge at Shaft

PLATE 44.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

Fig. 1.- Concrete in Shaft No. 5. Looking Down.

Fig. 2. Party Taking Sunflower Sections in Bonticou Tunnel.

No. 6 was found to be covered by 27 ft. of drift. This was readily penetrated in the ordinary way with timbering.

Shaft No. 7 was situated in springy ground at the foot of a steep slope at the base of the Shawangunk Mountains. About 35 ft. of drift had to be penetrated, and when only 12 feet down, soft clay was struck which caused settlement of the timbers. After a great deal of trouble, rock was reached, but a new set of timbers had to be placed inside the old for security.

The uptake shaft, No. 8, is to be surmounted by a large siphon chamber, whose foundations were planned to be carried down to ledge rock. The contractor, therefore, chose to sink the opening for the shaft through 43 ft. of drift large enough to include a portion of the chamber. The situation of the shaft appeared to offer difficulties, as it was started in the center of a small swamp. The shaft was started about 30 by 30 and timbered in the ordinary way, after a few feet of wet ground, hard clay and boulders were encountered. This gave opportunity to place and drive sheeting. At a depth of about 20 ft., soft ground was struck, causing considerable settlement of the sheeting, wales, etc., particularly in one corner. For a time it looked as if the whole framework would be wrecked. However, a new and more skillful superintendent was placed in charge, and built a stout horizontal frame on the bottom of the shaft, with its sides about 2 ft. from the sides of the shaft. This frame followed the excavation down, and from it small braces were run to support the bottom of the sheeting and keep it from coming in. In addition, long sheeting was given up and short planks, about 6 ft. long, were driven ahead as poling boards, in the same manner that they are used in earth tunnels. Using great care and caution, rock was finally uncovered at 43 ft. about six weeks after sinking began. To secure the shaft, a portion of the siphon chamber was concreted.

SHAFTS IN ROCK.

While the deep pressure tunnels were under discussion it was recognized that the shafts constituted the greatest problem, and on this account considerable hesitancy was felt in adopting them, and careful comparisons were made with steel pipe lines in the surface of the ground. Any one who is familiar with the slowness

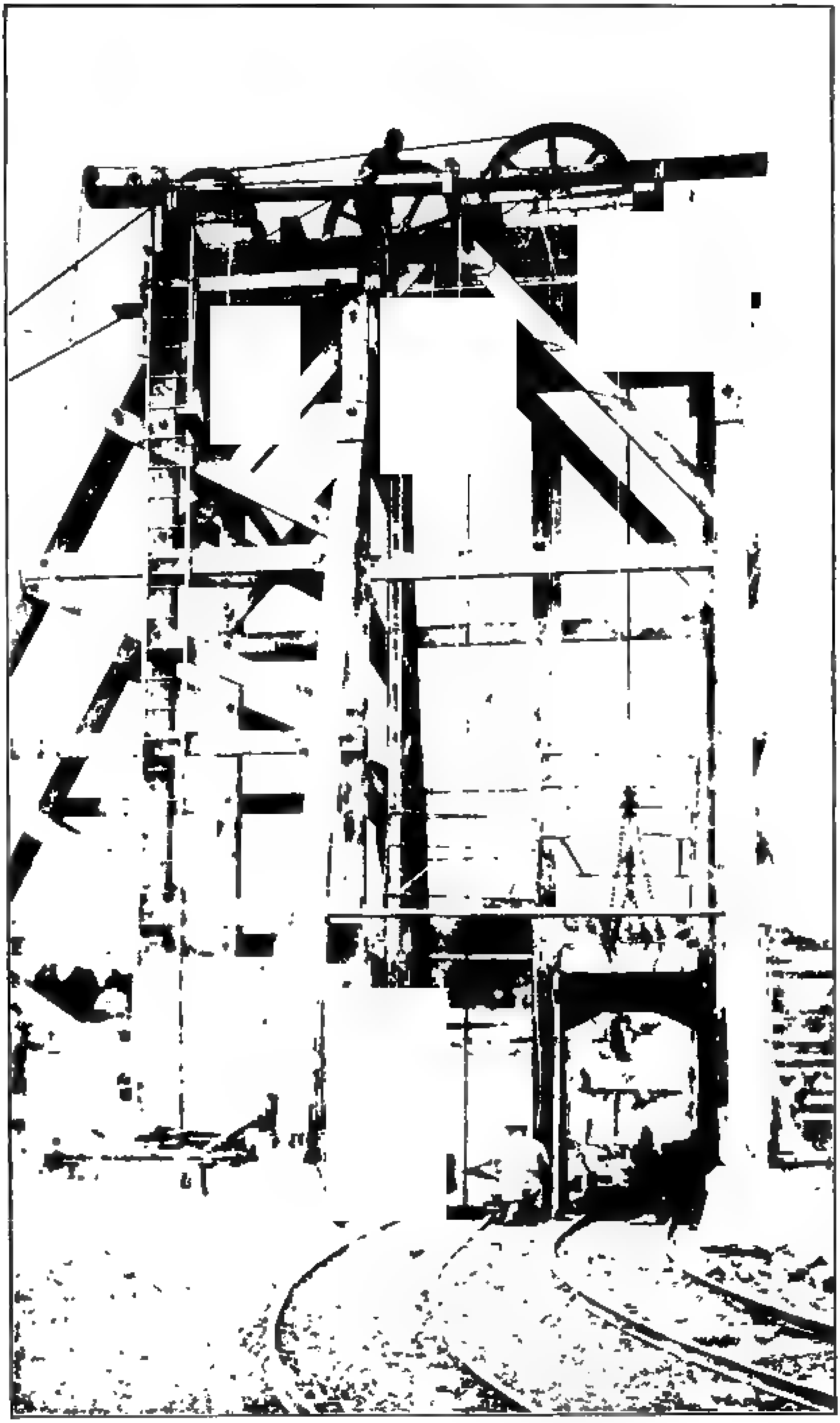
with which shafts under 100 ft. in depth are commonly sunk by contractors, will not wonder at this. To attempt to sink a deep shaft by ordinary rock men, as in tunnel work, is to invite failure, as in the case of the contractors for the first Hudson River test shafts. At the best, the work will be slow, tedious and costly.

In mining regions, where the operating companies have skilled rock men of all classes, deep shafts are commonly let to contractors who specialize in shaft work and who put them down surprisingly cheap and fast. At the outset of the work the T. A. Gillespie Co. secured the services of two shaft-sinking organizations from the coal regions of western Pennsylvania, the Dravo Contracting Co., for Shafts No. 1 and No. 2; the S. J. Harry Co. for Shafts No. 3, No. 4, No. 5 and No. 6. For Shafts No. 7 and No. 8 a skilled shaft superintendent from the coal regions was obtained, and the organization under him was of course benefited by the presence and rivalry of the two others. Nevertheless, although excellent work was done at these shafts, the work here was both slower and more costly than at the others. The shaft contractors having their plants and organization at hand, made very quick starts, plant and men arriving a very few weeks after the letting of contracts. Here, plants were operated independently until the main power house could furnish compressed air.

At Shafts No. 1 and No. 2, The Dravo Contracting Co. installed for each an independent little plant, composed of boiler, air compressors, dynamos, steel head frames, etc. Before the caissons at these shafts had been sunk, the main power house was furnishing compressed air.

Shaft No. 3 was supplied with a complete plant by the S. J. Harry Co., consisting of boilers, compressor, dynamo, headframe, hoister, etc., and the plant operated independently for quite a while, about 200 ft. in depth having been reached before air was supplied from the central plant. At Shaft No. 5 a good-sized steam plant was installed by S. J. Harry. This furnished power for Shafts No. 4 and No. 5. A depth of about 200 ft. was reached at Shaft No. 4 before the main plant was in operation, at Shaft No. 6 an independent small plant was used to sink to a depth of 150 ft. before use was made of the main supply.

A fine little compressor plant was installed by the contractor for



HEAD FRAME AND CAGES AT SHAFT NO. 1.

Shaft No. 7, and then operated till the shaft reached a depth of about 150 ft. This plant also furnished air for Shaft No. 8, using a part of the main power line.

Although the main power plant was constructed in a very short time, considering its size, the temporary shaft-sinking plants installed at the shafts saved about three months.

Although a very large and expensive power plant was installed, quite a simple and relatively inexpensive plant is usually installed by shaft-sinking firms for each shaft. At Shaft No. 3, notice to begin work was served on June 16th. The contractor's plant for Shaft No. 3 was then shipped from western Pennsylvania, and set up, a camp was built, and active operations were begun by the middle of August.

A good temporary plant was that installed at Shaft No. 1. It consisted of a return tubular boiler, bricked in and enclosed in a corrugated iron building, which also housed a compressor, dynamo, pump, etc. The hoisting engine, with single drum 3 ft. in diameter, was installed in a small sheet-iron building 40 ft. distant from the shaft. Although the engine gave good service till the shaft was put down its full depth of 590 ft. it is better not to use friction engines for shaft-sinking, as they are subject to great wear, and when weakened may at any time fail to hold a bucket when raising or lowering men or materials. A direct-connected engine without friction drum is much safer and more satisfactory. A small portable steel headframe erected over the shaft completed the plant.

THE MAIN POWER PLANT.

An almost ideal location for the power plant was found in a large level field between the public road and Rondout Creek. A siding could be readily constructed from the O. & W. R. R. near Shaft No. 4, and an unlimited supply of fine water for all purposes obtained from the creek.

The plant was carefully designed as a whole and not allowed to grow up piecemeal as in ordinary contractor's plants. Mr. Canniff, master mechanic for the company, experienced in the building of several contractors' power plants, planned to have the power house as efficient as possible. A careful estimate of the probable

amount of compressed air needed was made at the outset, and is as follows:

8 hoisting engines............	2 600 cu. ft. per min.
15 headings, 6 drills each......	5 600 " "
(Assuming one-half working at a time.)	
Miscellaneous use of air.......	1 000 " "
	9 200 cu. ft. per min.

The contract specified that compressed air was to be furnished for a certain minimum requirement (150 gal. at 6 shafts and 300 gal. at two shafts) with an emergency outfit capable of lifting 1 500 gal. per minute from the bottom of the deepest shaft. This figures up to the enormous total of 16 820 cu. ft. of air for pumps alone, or a total of 26 000 cu. ft. of free air per minute compressed to 100 lb. pressure.

To provide this amount of air, the power house was designed to hold ten cross-compound Ingersoll-Rand air compressors with compound condensing engines. The compressors were the Imperial type X-3, each with an average capacity of 2 400 cu. ft. of free air per minute. Steam at a pressure of 150 lb. is furnished by Sterling and Heine water-tube boilers, operating under forced draft, with a total boiler capacity of 2 500 h.p. In addition there is a large auxiliary plant consisting of pump and Curtis steam turbines for operating the dynamos, the whole being enclosed in a building 80 ft. by 160 ft. Adjacent to it is a machine shop containing a complete equipment of machine tools, for repairs. The distribution of compressed air was through a 12-in. pipe line, which gradually reduced to 8 in. at the terminal shaft. The pipe as laid was such as is used in the distribution of natural gas, employing the Dresser joint. Each pipe end is plain except for a slight bead. The pipes are butted together with a sleeve fitted over the end, and between this sleeve and two plates, which are drawn together by bolts, two rubber gaskets are compressed. The pipes are laid on the surface of the ground and lowered in place. As each joint is practically an expansion joint, the pipe can be laid to a very irregular profile. Except in one instance, no joint pulled apart. Considering the length of the line, over 4½ miles, this is very satisfactory service.

PLATE 46.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

Fig. 1.—Roof of Limestone Cave Between Shafts No. 3 and No. 4, Showing Waterworn Surfaces.

Fig. 2.—Waterworn Surfaces and Seams in Limestone and Cavey Ground South of Shaft No. 3.

Construction on the plant was started July 20, 1908, and by November 4th it began to supply air regularly to the various shafts, and to date there has been only one interruption of service, when, at a very sharp change in grade, the pipe line pulled apart. Moreover, it has never been overtaxed. At the time when all the headings were going at their maximum, its capacity was just reached, showing that it is well proportioned to the work. However, due to trouble with the use of air in very large pumps, a small auxiliary steam plant was installed at Shaft No. 4.

SHAFT No. 1 IN ROCK.

After the shaft had been excavated to rock, through 84 ft. of earth previously described, there remained about 516 ft. of rock to be penetrated to reach subgrade. A good deal of time had been lost in getting ready to sink the caisson, and progress was about one month behind. Nevertheless, in less than six months the shaft was put down, gaining about six months in the progress schedule of the contract. The first month only about 60 ft. in rock was sunk. The superintendents were changed so that the next month 100 ft. was made, followed in turn by another of 120 ft., and this by the record month of 138 ft. of shaft sunk with 132 ft. timbered. This could not be bettered as the shaft was then near the bottom. There were no shafts on record in this country at the time which had been put down at such a high rate of speed. The same organization later, at Shaft No. 1 of the Moodna Siphon, excavated 168 ft. in Hudson River Shale untimbered, and better still, recently, at Breakneck shaft, sank the shaft 183 ft. in granite. This is undoubtedly the best record for the United States. The best depth made in any shaft of record is that at New Klempintown, South Africa, 213½ ft. in one month, probably made by hand-drilling and Kaffir labor.

The cross-section and type of timbering is shown on Plate 43, although a considerable modification in the cage timbering, placed after the shaft was put down, was allowed.

While the design of the shaft was under discussion, there was considerable hesitation in adopting the circular shafts, as up to a very few years ago they were practically unknown in this country, although universal in England and largely used in other countries.

It was claimed by many American contractors that they would prove to be slow and difficult to excavate to line. This was apparently borne out by the experience of the contractors for the Hudson River test shaft, who, however, tried to operate without skilled shaft-sinkers. An investigation showed that in England from 3 to 6 ft. per day was readily made in circular shafts by skilled shaft-sinkers, including simultaneous brick lining. As there appeared to be no intrinsic reason against them, the circular section was adopted for all the permanent shafts.

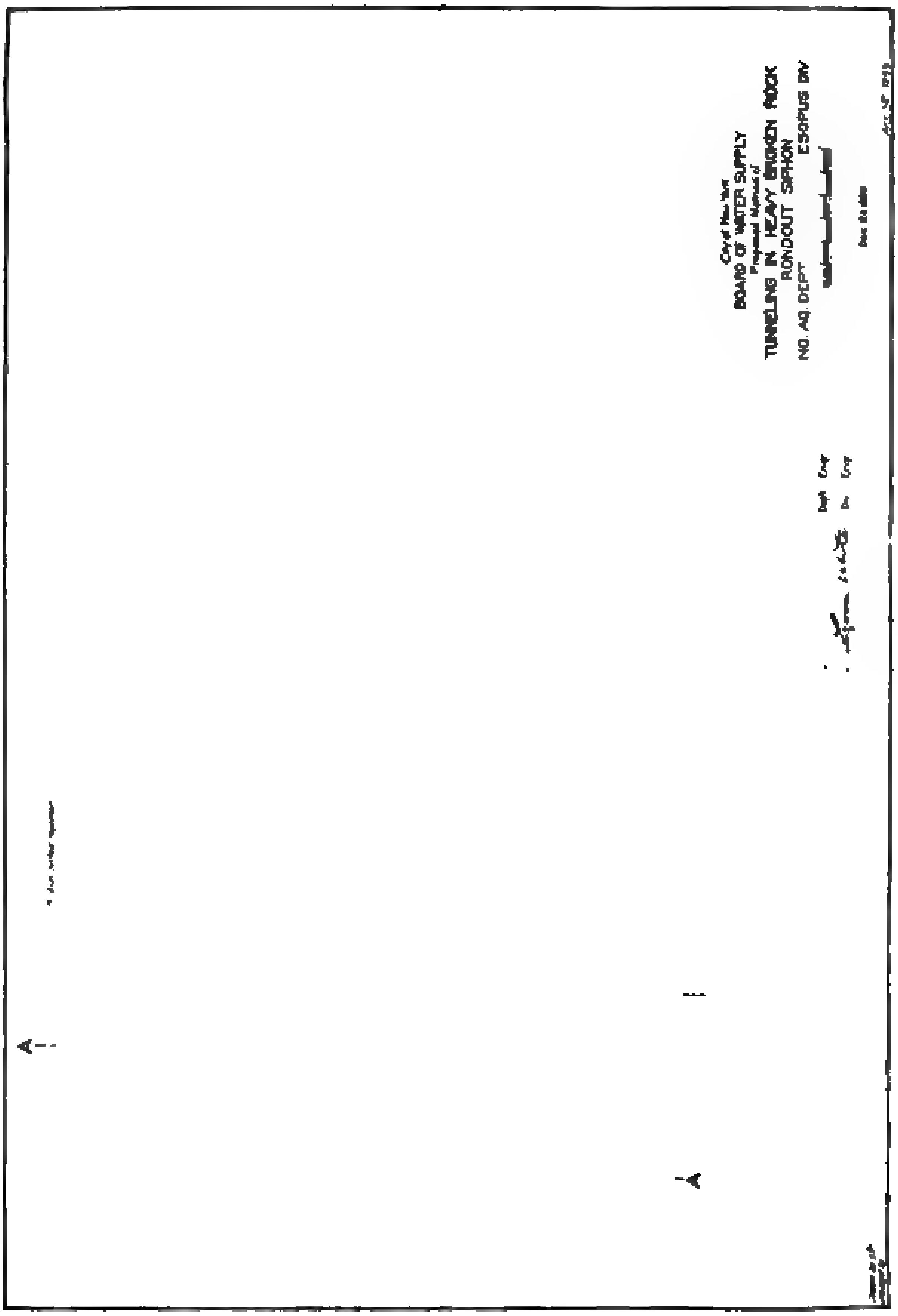
The first superintendent in charge of No. 1 had no experience sinking shafts of circular section, and at first it appeared that it was going to be slow work sinking and hard work trimming to the circular section. The first 60 ft. or so of Shaft No. 1 approximated the rectangular section due to the use of too few trimming holes, and the work of trimming out to make room for the segmental timbers was very slow. Another superintendent was secured with some experience in circular shafts, the first superintendent going to Shaft No. 2, a rectangular shaft. where he did excellent work.

The Dravo Contracting Co., in charge of the work at Shafts No. 1 and No. 2, imported a complete shaft-sinking organization from one of the contracts in western Pennsylvania or West Virginia. The men were Slavs, originally from southeastern Europe. The superintendent and foremen were Americans. The men appeared to be the steadiest, the hardest working and in their own particular sphere the most skilled, it has been my good fortune to see.

Mr. Styles, the superintendent, aimed to have a complete cycle of shaft-sinking operations in one day and not to attempt to make a greater advance than consistent with such a cycle. By this method, one day's advance while mucking was increased from 5 to 6 ft., and monthly progress, including timbering, from 100 to 138 ft. During the whole of three months, one could come here while sinking and find the men engaged on exactly the same work at a given time of day.

During the first shift, all the holes in the shaft were drilled from tripods. The rock, being Hamilton and Marcellus shale, was easily drilled. A circle of holes, called the cut holes, were first drilled to a depth of 8 ft., top of holes 5 ft. 6 in. distant from center of

PLATE 47.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.



METHOD OF TUNNELING IN HEAVY BROKEN ROCK USED ON RONDOUT SIPHON.

shaft. The holes were readily located from the bucket hoisting rope swinging in the center of the shaft. They sloped inward to blow out a cone. The second row, called relief holes, were drilled 6 ft. deep on 6 ft. 6 in. radius. The third or trimming holes, 16 in all and 6 ft. deep, were placed on the "C" line, or effective breakage line required, and were drilled quite close together. Close spacing of the trimming holes is particularly necessary in circular shafts. They save time in trimming and give the true shape. The five drillers and five helpers in the shaft took about 5 hours to drill 31 holes, a total length of 198 ft., at an average rate of drilling of 6 ft. per hour. The remainder of the 8 hours was used in hoisting drills, etc., out of the shaft and in "shooting" the central cone bounded by the 6 cut holes.

The second shift consisted of muckers, with the exception of one or two drillers, who did the blasting and any odd drilling necessary. They mucked out the sump and blasted the second round of relief holes. The third shift, consisting entirely of muckers, would muck out the material thrown down by the 16 trimming or rim holes. Usually, I believe the hardest work is to have the shaft cleaned out by the time the drilling shift arrive. By the above method, during the record month of March, 1909, an average of 5 ft. 9 in., was made per advance. This corresponds to about 57 yd. of rock shoveled into buckets in about fourteen hours. Each man filled about five buckets of muck in his shift, which is very fast work.

During the record month, drilling was done on 24 days, each day making an average advance of 5 ft. 9 in. Four of the days were Sundays when no work was done, with the exception of some timbering. Timbering took only 8 shifts. Not only was this shaft sunk faster and truer to shape than any other, but the timbering was also done better and much faster than elsewhere. During the record month, if the shaft had been allowed to go down without timbering, it is possible that by working on Sundays 170 ft. of shaft could have been sunk. However, only about 60 ft. of rock wall was allowed to be exposed at a time. Hitches or niches in the rock were then cut and on them heavy round sticks of timber were placed parallel to the segmental timbers placed above. On these "dead logs," the first set of squared segmental timbers was placed. The next set would be placed on posts so as to space bents 5 ft. apart, bolts fast-

ened between, lagging spiked on, and the space between rock and lagging thoroughly packed with cordwood. To facilitate the work, an ingenious platform was devised. This was built in three parts, so that by means of rings fastened to each it could be raised one section at a time, by the winding rope to the next bent, and on it as a secure and firm place to work the men could place lagging and packing. In the other shafts, platforms of loose plank were used which were not only slow to move, but were insecure, and caused considerable loss of time.

In commenting upon the progress at Shaft No. 1, it must be noted that the rock was very favorable, it being a dry and tight shale in about horizontal layers which broke true to the holes placed. But, nevertheless, it required a remarkable organization and methods to achieve the results noted. In addition, a heavy bonus was given based upon a monthly progress of 90 ft., each 5 ft. of timbering counting as one foot. During the record month, the men received about 40% of their wages as bonus. This was amply justified in the decreased cost per foot of shaft during the month.

It will be noted that the waterway shafts of the Rondout Siphon were all timbered before being concreted. As all the timbers had to be taken out before concreting, the question naturally arises, Why not sink in short stretches and concrete as you go down? This was considered when the designs were originally drawn up, but at that time it was thought to be too advanced a practice to be ventured on the first work of this character. The argument was that the shaft-sinking would be delayed by the concrete lining and therefore delay the tunnel. It was also thought that a better lining could be secured by concreting from the bottom up in one stretch. There is some force in the argument against concreting while sinking, but all the later siphons have their waterway shafts concreted in short stretches while sinking, no timbers whatever being placed in the shafts. It is thought that considerable economy is effected by omitting the timbering and using the concrete lining instead to support the sides. This method has one great advantage in sinking through wet ground in that the concrete cuts off much of the leakage into the shaft, and whatever water-bearing seams are encountered may be grouted or led away to ring pumps. In addition, as it is difficult to get ordinary concrete men to work in deep shafts, shaft-sinkers can move and set the forms much quicker.

PLATE 48.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

TEMPORARY ROOF SUPPORT SOUTH OF SHAFT No. 2

In order not to interrupt the work in the tunnels while shaft lining is going on, it was planned to place the cages in an independent tower in the center of the shaft so that the lining could be placed while the cages were in operation. The contractor chose, however, to use a much larger cage than contemplated in the design, and this feature, as shown on Plate 38 of Mr. Wiggin's paper, was sacrificed. What was actually placed is shown on Plate 43. It is doubtful whether the form for the concrete lining could be satisfactorily raised and set with the center of the shaft encumbered by cage timbering. Where masonry lining is commonly placed while sinking in Europe, brick is usually employed. However, in this country concrete-lined shafts are common and have been employed by the U. S. Steel Co. in the elliptical shafts of their West Virginia mines. These shafts are not timbered, but the concrete lining was placed while sinking, as in the shafts of the Wallkill and Moodna siphons. The elliptical shaft gives more cage room for a given area than the full circle used in our siphons.

On Plate 39 of Mr. Wiggin's paper is shown a suggested scheme for sinking and lining circular shafts. This method, although shown on drawings for the Wallkill, Moodna and Croton siphons, etc., is only a suggestion, and appears to me more suitable for brick than concrete lining. It is taken largely from English practice. However, the contractors chose to sink the shafts in a simpler way, not attempting to place concrete while actually mucking the bottom, but interrupting shaft-sinking while concreting and moving forms in the usual American fashion. This, I believe, was wise, as it subsequently proved that at the high rate of speed the tunnels were excavated and lined, the hoists at the shafts were pushed, even though balanced cages were operated at the speed of 400 ft. per minute, raising the larger cars made feasible by the larger shaft ways.

Plate 43 shows cross-section of construction and waterway shafts as actually constructed. It will be noted by comparing these with the contract drawings, as shown in Mr. Wiggin's paper, that much larger cageways were used then than originally contemplated. To accomplish this it was necessary to enlarge the excavation in the case of the rectangular shafts, and to rearrange the timbering in the case of the waterway shafts. The enlargement of the shafts

had to be made at the expense of the contractor, as the prices bid were per linear foot. The contractor was given the option of enlarging the temporary shafts if he deemed it advisable. In this case, the area excavated was increased about 70 sq. ft., or 31%, allowing increased cage areas of over 100 per cent. This probably increased the cost of the shaft only about $10 per ft., as it meant only that much more mucking and somewhat larger timbers to handle. On a 500-ft. shaft this would amount to only $5 000, a charge of only 5 cents per yard of muck and concrete handled. This additional expense was more than compensated, in my opinion, by the increased capacity of the cages, and freedom of getting materials in and out of the tunnels. Tunneling and concreting, at times, has to be forced at the highest obtainable speeds, and averages are deceptive. For instance, over the entire period of this contract, only an average of 7 yd. per hour need be handled by two cages, whereas at Shaft No. 7, during the maximum tunnel driving (also the most economical), 20 yd. of muck per hour were removed. In addition, men and materials had to be lowered and hoisted, taxing even the large cages to their capacity. During concreting, as much as 30 yd. were placed per hour. The additional room provided was invaluable at Shaft No. 4, where at times even the enlarged space was crowded with pipes and pumps.

On the basis of Gillespie's experience, the Degnon Contracting Co. adopted even larger shafts for the Wallkill than were used on the Rondout, and, so far as known, never regretted it.

Larger cageways are secured at the circular shafts by rearranging the timbering, as shown on Plate 43, doing away with the independent tower shown on the contract drawings. Nevertheless, these cages were about 1 ft. narrower than those used in the rectangular shafts, causing the use of smaller cars for muck and concrete. This was something of a handicap, and there was not the same freedom as at the other shafts.

Too much is made of the analogy between deep tunnels driven from the bottom of shafts and mines. Superficially they are much the same, but actually quite different. A mine has many levels and workings, so that materials can be regularly moved toward the shafts, thus using the cages at about maximum capacity for the whole day. For the deep tunnels, we have only two headings and

Fig. 1.—View Showing Timbered Section in Broken Limestone and Cavey Ground South of Shaft No. 8.

Fig. 2.—Placing Concrete Invert. Rondout Siphon.

two small working faces, from which the muck comes only intermittently, due to the interruption from blasting, etc.; thus, at times, the cages are nearly idle, at other times worked up to the maximum capacity. Mining men have not been found to work well in the long, straight-away driving of tunnels, as they are used to independently working in small gangs in the workings, and laying off at their own convenience. A tunnel, to go well, must have the men under strict discipline, reporting every day at the same time and working at the same speed throughout one shift. This proves irksome to mining men, who usually drift away from tunnel jobs. Similarly, mining engineers do not do the bulk of tunnel-driving. Long tunnels are usually in charge of civil engineers or superintendents, not especially identified with mining work.

SHAFT No. 4 AND TUNNEL No. 4 NORTH.

By far the greatest difficulties encountered in the construction of the Rondout Siphon were those at Shaft No. 4. Here the porous Binnewater sandstone and High Falls shale had to be penetrated both in shaft and tunnel. In the shaft they yielded a flow of 1 000 gal. or more per minute, and even more in the tunnel. These difficulties, by the energy, skill and persistence of the contractors, were finally overcome by replanting the work several times, and, in the case of the shaft, by the free use of grout in cementing the open seams. This is thoroughly described in Mr. J. P. Hogan's paper of May 16, 1911, presented to the American Society of Civil Engineers, and Mr. B. H. Wait's article of June 17, 1911, printed in the *Engineering Record*. It is not claimed that the methods used here were original. They merely illustrate what can be accomplished by the thorough application of machinery and generally known devices at the command of engineers and contractors. Of course, great credit must be given to the T. A. Gillespie Co. for their energy and for their willingness to spend large sums in combatting the water with the most improved pumps and devices which could be obtained.

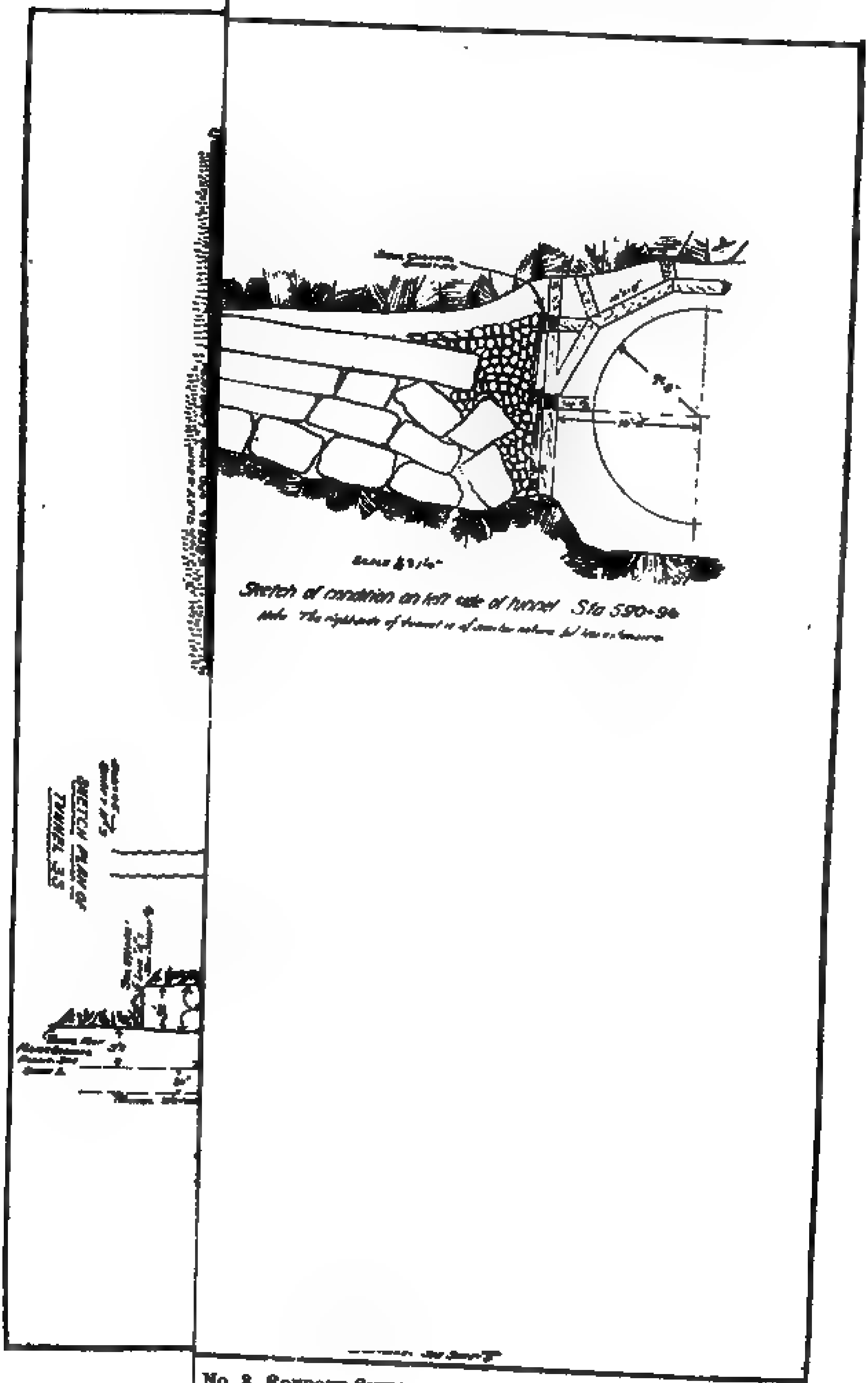
TUNNELING.

Much litigation and dispute over payment for excess breakage has been the experience on previous tunnels. In order to secure a definite thickness of masonry lining, it is necessary to break some-

what beyond the specified masonry lines. In some cases this has been left to the contractor and all breakage paid for, leading to very careless and wild work, and, as the contractor benefits by this, difficult to prevent. This method on some of the Chicago lake tunnels added enormously to the estimated cost. One or more of the contractors purposely drilled the holes wild. In the case of the New Croton Aqueduct, no payment was made for excavation outside of the specified masonry lines. This led to prolonged litigation, the contractors finally securing partial payment through an Act of Legislature.

The Designing Engineers for the Catskill Aqueduct made an extensive study of well-driven tunnels, and came to the conclusion that it would be well to adopt the lines shown on Plate 37 of Mr. Wiggin's paper. Here, payment is made to the "B" line in any case, although it is possible to save by careful driving in good rock about 8 in. around the perimeter. The "A" line is a dead or clearance line, the "C" line, 5 in. outside, giving the desired effective thickness of lining. In rough rock, if points of rock only are allowed to touch the "A" line, the desired effect will be accomplished. In a closely-driven shale tunnel the excavation may very closely approach the "C" line, in which case the contractor would be paid for more than he takes out, but he is felt to be entitled to this for his careful work. In case of excessive breakage outside the "B" line, he is not paid for this excavation, but only for excess concrete, at a fixed price of $3 per yd. As this will not yield a profit, it is not to the contractor's interest to break outside the "B" line. It was felt that the adopted payment lines would be fair to both parties, and this has been the experience so far. Very close driving was sought for by both the engineers and the contractor on the Rondout Siphon. After each shot, the face of the heading was carefully painted in red, the "C" line being used. From this the heading boss or superintendent laid out his holes. In addition, the heading was trimmed just behind the face, which was found to have a very good effect on the driving. Cross-sections by means of the "Sunflower" were taken about every 10 ft., and plotted in pencil on cross-section sheets. These were shown frequently to the superintendents. Locations of "collars" and "butts" of holes were also made from time to time and plotted on the cross-section to show how the holes were drilled.

PLATE 50.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.



No. 2, Rondout Siphon.

In this manner very accurate sections were obtained, the contractor saving considerable in excavation and concrete. For instance, the Bonticou grade tunnel, 3 400 ft. long, saved 856 yd. over "B" line excavation. This, however, was very close work, and it is not felt that, ordinarily, the contractors will save much over the "B" line. The same system was applied to the sinking of the circular shafts, which were paid for on the yardage basis. Shaft No. 1 was drilled within the "B" line, the contractor saving 211 yd. of excavation in 400 ft. of shaft. At Shafts Nos. 5 and 8, little saving was made. In the circular section, the bench or lower half gives the most trouble, as this has to be taken out with vertical holes. Close results were obtained by driving a little narrow in the softer rocks and then trimming out later to exact lines with jap drills. This does not pay in the harder rocks and, consequently, there is some tendency to be wide at the bottom.

The ordinary American top-heading method was used in all cases, as shown on Plate 42, Fig. 2, for pressure tunnels. The bottom holes, however, have to be gaged differently than there shown, the horseshoe grade tunnel being much easier to drive. This method is so well understood and is in such general use in this country that it is hard to improve upon it for economy and speed. During the month of November, 1909, in the south heading of Shaft No. 7, an average of 488 ft. of heading and bench was made in Hudson River shale.* This was considered the best American record for this class and size of tunnel, until broken on the Wallkill Siphon, in 1910, by similar methods, where 523 ft. was made.† About 22 holes were placed in the heading, 6 cut, 6 side and 10 trimming holes. Cut holes were 10 and 12 ft. deep, side holes about 8 ft. deep. Bench holes were 4 ft. apart and four to a row. All holes were loaded, and the cut holes were fired first and then the side holes. Three shifts of drillers were used in the fastest work, each drilling and blasting before quitting. The drilling force consisted of a heading foreman, 6 drillers, 6 helpers and 1 nipper. Mucking proceeded with the drilling, the force for each of three shifts consisting of 1 foreman, 6 shovellers in heading, 4 wheelbarrow men, 6 shovellers on bench, and 2 mules and drivers. In most cases,

* See *Engineering Record*, January 1st, 1910, article by J. P. Hogan, on "Progress on Rondout Pressure Tunnel."

† See *Engineering News*, October 20th, 1910.

only two advances were made per day in shale, and in hard rock only one advance. The best month's progress during heading was 461 ft.

Many attempts have been made to improve on the American top-heading method, but it seems to the writer that, with a good organization, it is hard to better. It is true that the bottom-heading method, as used in Europe, leads to great progress, as much as 1 000 ft. having been driven in hard rock in one month in Switzerland. Enormously large forces of men are used, however, the number of men quartered at a portal being 4 or 5 times as many as are employed in this country. Even with the high speeds and low wages paid, the cost per foot of tunnel driven is much greater. This, perhaps, is proper for a 12-mile tunnel, but would be altogether out of the question for the ordinary American tunnel. With the progress now common to long American tunnels (300 to 500 ft. per month) it takes but a few years to drive a tunnel several miles long.

The bottom-heading method has been used to some extent on several short tunnels of the Catskill Aqueduct. As there used, it is not the Swiss method, but rather the reverse of the ordinary American method. The lower half is excavated as heading, and usually holed through before the top is taken out. A moving platform is erected, upon which the drills are set to drill the top, using holes nearly parallel with the axis of the tunnel. The top heading being shot down onto the platform, the muck is shoveled into cars below through trap doors. This has the advantage of saving the bench mucking and shoveling upward into cars, as in the ordinary method, but has the disadvantage of having the platform to bother with, and the increased cost of drilling all horizontal holes. Besides, if there is any ground needing support with timbers or steel, the bottom heading is dangerous or becomes very expensive. Undue risk must be run or timber first set up taken out, or, as an alternative, the very expensive fan-shaped system used in Switzerland adopted. Carrying the heading through is economical in short tunnels, but not where the heading is of unavoidable length (say 1 500 ft.), as the bench can be carried along with proper organization without materially holding back the heading. Fixed and overhead charges, which are high in tunnels,

PLATE 51.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

FIG. 1.—METHOD OF TAKING CARE OF VERY WET SEAMS BETWEEN SHAFTS NO. 2 AND NO. 3.

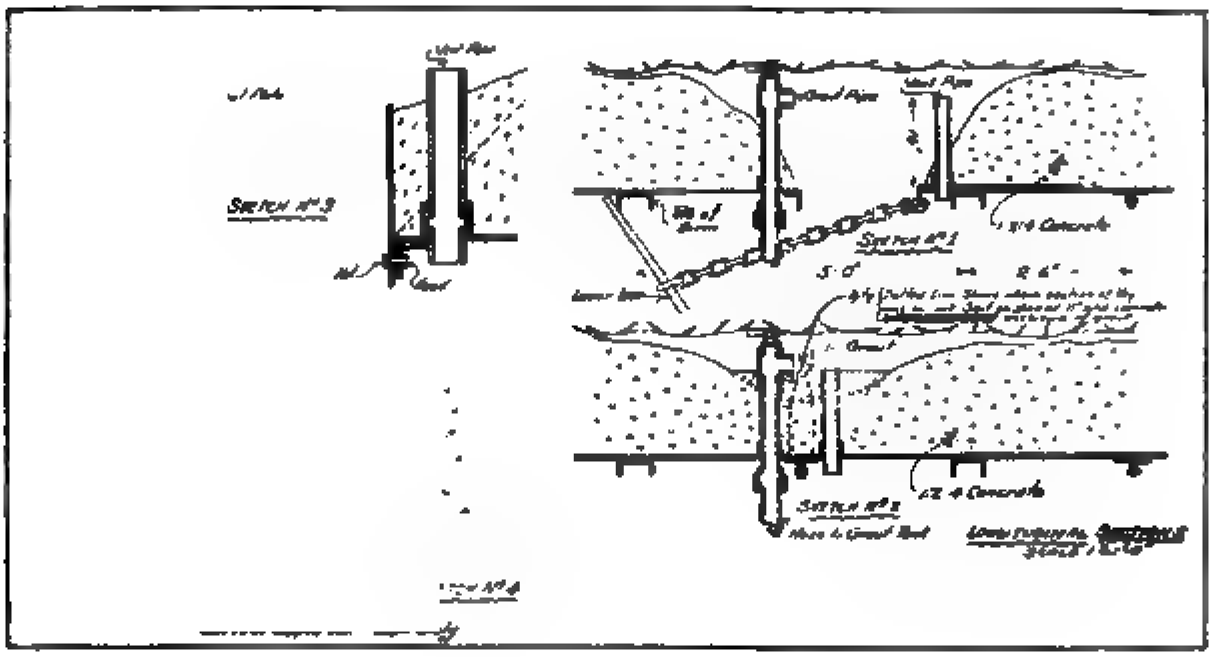


FIG. 2. METHOD OF MAKING CLOSURE IN ARCH KEY.

have to be borne for a much shorter period for the combined heading and bench method.

The Shawangunk grit and some beds of Helderberg limestone, particularly the top flinty bed (Port Ewen), proved difficult to drill, taking three shifts of drillers to make one advance of 7 ft. This cut down the progress to less than 200 ft. per month. In shale rock, usually two advances per day would be made to one in grit. It was found to be difficult in the hard rock to trim with jap drills, so an effort was made to get the tunnel to shape in the first instance. This, as before stated, resulted in the tunnel being driven a little larger in these hard rocks, but this could not be objected to, as trimming was found to be very expensive and slow, particularly in the grit.

Tunneling in Difficult Ground.

The first stretch of heavy ground encountered was that between Shafts No. 4 and No. 5, just below the contact of grit and shale. Here, by faulting, the Hudson River shale was loosened from the overlying grit, and its level beds caused a heavy load to be brought upon the first temporary timbers placed. Fearing that it would be difficult to remove this timbering previous to concreting, they were taken out and the structural steel of the contract drawing placed, but this proved inadequate to carry the load of 20 to 30 ft. of loosened rock, and the steel ribs began to buckle. This was soon caught up by temporary timbers supported by hitches in the rock walls. The steel bents will be carried by longitudinal I-beams, which are to be placed just before concreting.

Soon after the above occurrence, heavy ground was struck south of Shaft No. 3, at Station 587+50, after penetrating 2 150 ft. of Helderberg limestone. This rock proved to be here much shattered by faulting, and consisted of large, irregular limestone blocks, separated by clay seams, some of them water-bearing. One clay seam proved to be many feet wide. Conditions here are shown on Plate 46, and on one of the sketches of Plate 50. For the reasons stated above, a new design for structural steel roof support was prepared at the Esopus Division office. Before this could be fabricated, in order not to interrupt timbering operations, temporary timbers were placed in this bad ground by carefully excavating at roof level

with top heading, supporting the roof by temporary wooden poling. Arch bents were so placed as to allow of the replacement of wooden lagging, etc., by steel, in accordance with methods shown on Plate 47, and Plate 49, Fig. 1. The contract specified that no wooden lagging, etc., should be left back of the concrete lining, as it was feared that the heavy internal pressure of the tunnel, when in service, would compress the wood and crack or rupture the concrete.

The method of tunneling through heavy, broken rock, as shown on Plate 47, and on Plate 49, Fig. 1, was designed to meet the difficult conditions where the rock was too shattered and broken to support itself, and yet was hard enough to prevent the driving of poling boards in advance. This is accomplished by the use of a few different lengths of steel channels and I's and wooden timber bents. The principle is to expose as little roof as possible and immediately catch it up with supports and gradually widen the top heading to the full width desired, then to deepen and put in wall plates, and then trench to subgrade. The writer wishes to acknowledge his indebtedness to Mr. J. C. Meem for the general plan, although no use is made of Mr. Meem's poling boards operated by jacks. The plan shows a full section supported, but it can be used to support only a part of the roof or sides, in case the remainder is self-supported. As used on the Rondout Siphon, there never was occasion to use the full section. In one case the roof and a portion of sides was supported; in another the sides only.

At Station 590+78 a great overthrust fault ground up much limestone and opened a bed to solution, forming a considerable cave, which was subsequently silted up by fine clay with some glacial sand washed in from the surface. This was in spite of the fact that the elevation of the tunnel here is —100 and the lowest point of gorge nearby is sea level. Near this fault, the rock became blocky, and wet seams were tapped and exposed. A pilot hole was driven ahead, showing solid rock. Nevertheless, a shot opened up a great cavity filled with soft clay to the left, and a small underground stream was seen flowing beneath a heavy limestone bed. The pilot holes happened to penetrate the sound roof of the cave. As this heading was well advanced toward Shaft No. 4, it was shut down in the hope that the heavy pumping there would help drain out the water. This proved to be the case. The heavy mud seam

PLATE 52.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

Fig. 1.—Six-stage Centrifugal Pumps, near Shaft No. 4.

Fig. 2. Concrete Bulkhead, near Shaft No. 4.

was supported by the method shown on Plate 47, and successfully passed. Later, a succession of minor clay-filled caves and seams were passed. Some of these ran vertically far into the roof, as shown on Plate 50. A run from one of these nearly overwhelmed the men working in the heading, burying the drills under a mass of soft clay. This seam when cleaned out gave no further trouble. By always driving a top heading and using the roof of the old cave as the roof of the tunnel, although several feet high, the broken rock was safely removed. The clay in the seams was held by steel lagging. Had it been attempted to pass this ground by bottom heading methods, great quantities of timber supports would have been necessary, and the work would have been very hazardous. Luckily the bottom of Shaft No. 4 was 150 ft. below this heading (Elevation —250) and the great amount of pumping there lowered the ground water. Otherwise the difficulties experienced would have been much greater, as a little more water might have caused great quantities of mud to flow in from the seams and caves. The enlargement of the sections at the bad ground will plug the seams, etc., with sufficient thicknesses of concrete to bridge or arch over the seams, and adequate grouting behind will render this portion safe against internal pressure after filling.

During the driving of the experimental tunnels, it was discovered that a great saving in timber, excavation and concrete could be made by using three-piece timbers in moderately heavy ground, placing them in the ordinary tunnel section and taking them out in advance of the concrete. About 10 000 lin. ft. of the roof on the Rondout Siphon was thus supported, most of which has been successfully removed. It is surprising how strong this simple type of timbering is and how well the hitches hold even in crumbly shale. This is because the side pieces tend to press outward, instead of downward. The timbers are usually placed above the springing line of the tunnel arch, so that invert and sidewalls can be concreted before they are removed. The timbers are shot down with small charges of dynamite placed behind them. This brings down whatever loose rock is above and makes scaling safe. On the Wallkill Siphon, the timbers were brought down by attaching to them the cable of a hoisting engine and pulling the bents over. By using longitudinal I-beams over temporary timber bents, rather heavy

ground could be successfully and economically passed, one end of the I's being concreted in and the other supported on bents not yet removed. This method was suggested to pass ground which was feared would scale too badly if all support was even temporarily removed.

CONCRETING TUNNEL.

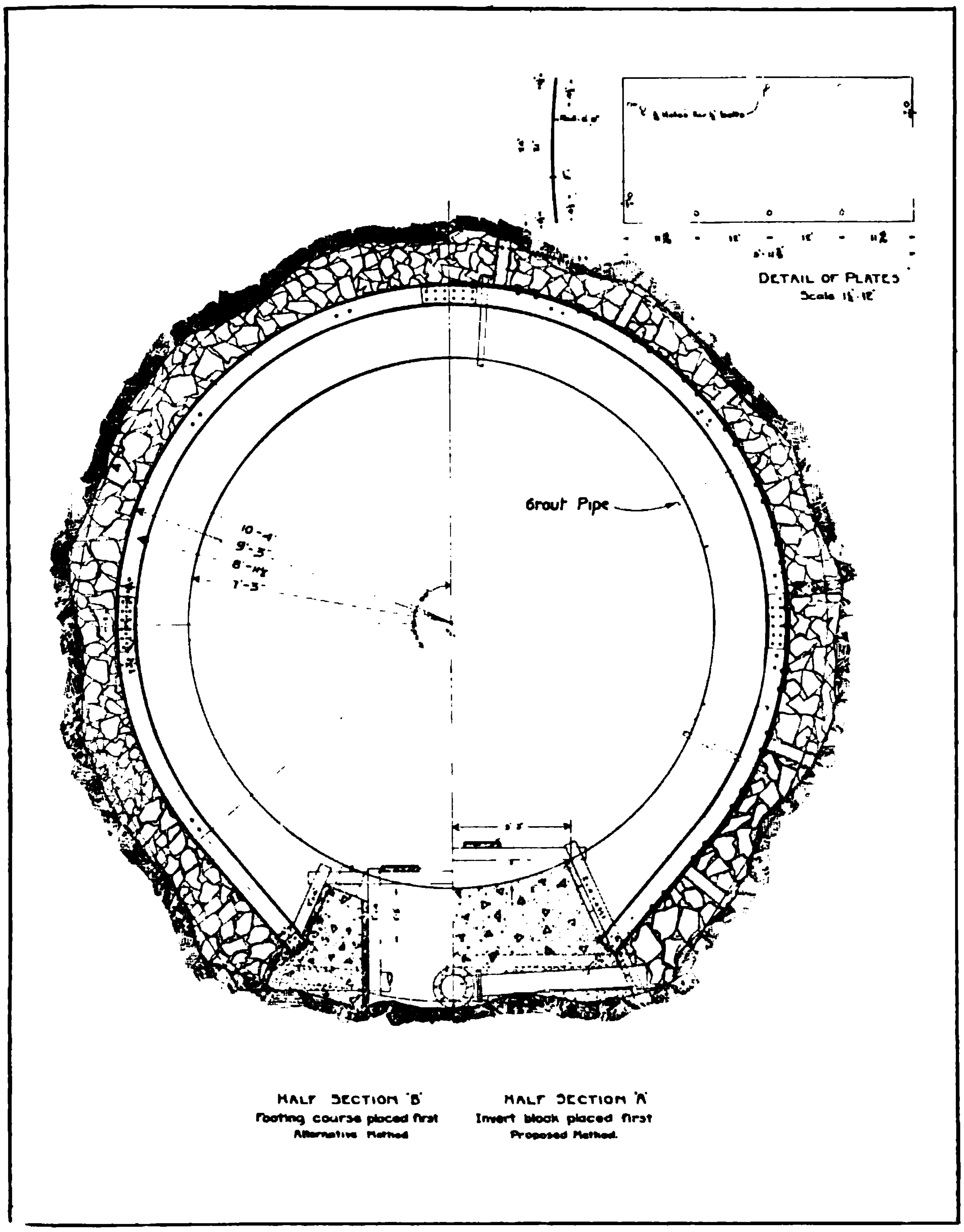
The concrete in the tunnel was placed for two main purposes: (1) to prevent leakage outward from the tunnel; (2) to present a smooth surface to the flow of water and prevent loss of head from friction. Since the concrete lining was to be put in, it had to be strong enough to withstand the outside pressure when the tunnel was empty. A circular section was adopted as being the most economical, and a 17-in. average thickness of lining was required.

The circular section presented new problems in construction. Most circular tunnels concreted to date had been of small cross-section, of short length, and mostly lined with brick. The forms for this tunnel would necessarily be very heavy, and the work of moving and setting them up a big item of expense to the contractor.

It was originally intended to place concrete pedestals under each rib of the forms and to place the whole circular section of concrete at one operation. This was tried and found very expensive. The contractor then devised a new method, which proved very adaptable to the work, cut down the cost, and increased the progress. This method, which is given below, has been followed in nearly all the pressure tunnel contracts on the aqueduct. The concrete was placed in three stages: 1st, invert; 2d, side wall; 3d, arch.

INVERT.

After cleaning all muck from the bottom, continuous wooden forms were placed for a 5-ft. invert strip. These side-boards were set on a radial line, tied together with ties and spreaders, and braced down. They had a depth equal to the average required thickness of concrete lining. The concrete was then placed, either by dumping directly from the cars or by wheeling in barrows from a dumping board at the forward end of the forms. The concrete was allowed to run out level below the side-boards. When the forms



METHOD OF PROTECTING CONCRETE FROM WATER IN VERY WET GROUND AT SHAFT NO. 4.

were filled, the concrete was shaped up roughly with a shovel, and as it stiffened, was worked to the required curve by use of screeds and trowels. The 5-ft. width of invert was adopted, as it gave sufficient width for a carriage for the upper forms, and did not have enough rise to make screeding particularly difficult. The progress per day varied from 75 to 250 ft., depending mainly upon getting the bottom mucked out and the forms set up. The concrete was all placed by the day shift, the other two shifts being used on mucking and forms. A section of the invert is shown on Plate 54, Fig. 1.

Side Walls and Arch.

After the invert had been placed, the side wall and arch forms were erected on a carriage, which ran on the invert concrete. The forms were of steel, semi-circular, and for use either on the lower or the upper half of the tunnel. Their special features consisted of lagging panels and a collapsing turnbuckle at the springing line, by which they could be pulled in, raised or lowered as the case required, and pulled ahead for a new setting. The special feature of the carriage was the bevel wheel used, which fitted the curve of the invert. A small hoisting engine furnished the power for pulling the forms ahead. These forms had a space between the springing line braces and the invert sufficient for a mule and a car of concrete to pass through to the adjacent forms.

During the first season's work the side wall concrete to the springing line was first placed, and after a section of the tunnel side wall between adjacent shafts had been completed, the forms were reversed and the same stretch of arch was completed. In this method, forms 40 to 80 ft. in length were used for the side wall and were filled in from 8 to 12 hours. In the arch, 40-ft. lengths were used, and were filled in 24 hours. By the first method, the side wall concrete was placed very cheaply and good progress made, but the keying of the arch was very expensive and slow, owing to the small number of men actually placing the concrete, compared with the number engaged in getting the concrete to the form.

During the second season, the arch form was set up, trailing the side wall form. In this case, the arch form was filled up to the key and the side wall form filled to springing line while the

key was being placed. This lined 40 ft. of tunnel per day, gave a finished job as it progressed, and saved a great deal of labor of moving inclines, track, etc. An incline was used in all cases to get the concrete from the invert to the platform at springing line level. A small air hoist pulled the cars up the incline to the platform. The concrete was dumped from side-dump Koppel cars onto the platforms and shoveled into the forms. All lagging panels were left in place on the side wall forms and about half-way on the arch. The rest of the arch panels were added as the concrete was placed. Radial boards were placed next the key-plates and the concrete banked up above these as steep as it would stand. The key concrete was then placed as fast as possible. These boards were not placed for the first 10 ft. of form, as this much of key could be placed while the remainder of the form was being banked up. Practically all except the key concrete was shoveled directly into place by the men standing on the platform at springing line. The key concrete was shoveled onto a temporary platform, about 3½ ft. above springing line, and shoveled from there into the arch.

All concrete was mixed on the surface at the top of the shaft in revolving Smith or Chicago Cube mixers, dumped into Koppel side-dump cars of 1-yd. capacity, lowered on the shaft cages, and hauled to the placing point by mules. The track for hauling was laid on the finished invert. Three forms were generally placed in each working stretch, and each form was then concreted every third day. One incline was used for each stretch, it being mounted on a car and transferred from form to form as necessary.

Several methods were tried of making the closure, where a form joined the work ahead. The best is shown on Plate 51, Fig. 2.

Materials Used in Concrete.

The concrete was generally mixed in the proportions of 1 cement, 2 sand and screenings, and 4 crushed stone. The cement used was Giant and Alpha, and was rather slow-setting. The sand was of good quality, having less than 1% of vegetable matter, and was well graded. It was obtained from a sand-pit near Shaft No. 5, and was either carted or conveyed by tramway to the shafts. The stone was obtained from quarries opened up near the line of the tunnel, and was all Shawangunk grit. All stone over ¼ in.

PLATE 54.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

FIG. 1. CONCRETED INVERT, NEAR SHAFT NO. 7.

FIG. 2.—COMPLETED CONCRETE IN RONDOUT SIPHON.

was used as stone, and the rest was run in with the screenings. The sand and screenings were mixed for fine aggregate, from 30% to 50% of the total being screenings.

The concrete was mixed plastic for the invert and arch, and wet for the remainder of the work. The wet concrete could not be used in the invert because of the circular bottom, and only in the first 8 in. or so of the key, as it could not be rammed into place. A cross-board, about 8 in. high, was used over the key-plate, so that the 8 in. of concrete covering the plate could be placed very wet and form a tight connection at the radial joint. The side wall concrete and all arch concrete, except the key, was placed wet, kept level, and well worked and spaded. Keys for water-stops were placed on all longitudinal and vertical joints except the radial joint at the key. The concrete in the arch was rammed as tightly as possible against the rock, and grout was used later to fill the space left by the shrinkage of the concrete away from the rock.

Care of Water in Concreting.

The one object sought for in concreting the pressure tunnel was to so take care of the water coming in that it would cause a minimum amount of damage to the concrete and lead to no porosity, which would let the water out when the tunnel is under pressure. To take the heavy internal pressure great pains were taken to place the concrete in contact with solid ledge, and all loose pockets of rock were cleaned out, and in seamy rock, the section was increased. Secondly, rich and wet concrete was used, it being found feasible to use a very wet mixture, thoroughly worked, throughout the entire circumference of the circular tunel. The body of the concrete, well worked in level layers and carefully keyed up as described, showed very few leaks. Wherever water percolated and showed as springs in the rock, it was carefully led through the concrete by means of pipes. Seams were calked so as to lead the water through pipes, and wet areas protected by sheet iron drip pans, the low points of which were drained by pipes. Even a slight seepage was taken care of in this way, as it was found that any neglect in this respect would lead to the water gradually working its way through the green concrete covering porous areas. By carefully providing for all water and seepage in this way, surprisingly good

results were obtained, the concrete in very wet areas being fully as good and as tight as elsewhere.

The greatest problem was met north of Shaft No. 4, where, in a distance of about 250 ft., there are innumerable leaks, amounting in the aggregate to 1 000 gals. per minute. In this place a special protection for the concrete lining was devised by Mr. Wait, as shown on Plate 53. Steel ribs were erected upon longitudinal angles. Bedded in the invert concrete on the ribs, the plates are placed shingle-fashion and erected as the concrete progresses. It is expected that 2 ft. of good concrete can be placed under the protection of this steel. Subsequently, after the lining on each side of this structure is placed, the section will be grouted, the water being then quiescent.

Although the tunnel is hundreds of feet below ground water, and without water-proofing, the net result will be that it will be dry enough to serve very well as a subway tube. What little water works in would do good, rather than harm, in keeping the atmosphere clean. Were reliance placed on bituminous water-proofing, rather than good and careful concreting and grouting, the expense of water-proofing would have been enormous and the result very doubtful. It seems highly probable that much of the expensive water-proofing resorted to in subway construction could be dispensed with and the same or better results reached in a far more economical way by careful concreting and grouting, with good provision for drainage.

GROUTING.

As stated under "Concreting," at all wet areas and springs pipes were placed to lead off the water and prevent injury to the green concrete. These pipes served a double purpose, as they were subsequently used for grouting. Pipes were also placed leading to all pockets which might not be thoroughly filled with concrete. In addition, every few feet, pipes were placed, some of them to the highest point of the tunnel roof, to serve as "vent pipes"; others, shorter, to serve as "grout pipes."

In general, pipes were placed according to the simple system shown on Plate 48 of Mr. Wiggin's paper,* it being found inadvis-

* Paper No. 51, *Proceedings*, Municipal Engineers, for 1909.

PLATE 55.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
WHITE ON CONSTRUCTION OF RONDOUT
PRESSURE TUNNEL, CATSKILL AQUEDUCT.

Form Used for Quarter Bend at Bottom of Shafts No. 1 and No. 8.

able to use the complicated system of "vent pipes," "weepers," "collectors," etc., shown for supported tunnel. Simple straight pipes serve all purposes and are much easier to place; they also keep clean before and during grouting. A special case of treatment of a heavy water-bearing seam yielding gas is shown on Plate 51, Fig. 1.

During the first concreting of the arch, in every section of arch concreted (about 45 ft.) a cut-off wall of concrete was carefully placed at a low point in the profile, or the arch was calked with oakum and mortar at the end of a day's work. This was as specified for the purpose of grouting short stretches of arch under pressure. In every case where possible concrete was placed solid to the roof, dry packing being used only for exceptionally high places. It was realized that the settling of the green concrete away from the roof would leave plenty of grouting space, and that dry packing was unnecessary for this purpose.

The contract provided that the grouting was to be done up to a pressure of 300 lb., and for this purpose Westinghouse high-pressure air pumps were used to raise the normal pressure on the air lines, also Canniff tank grout machines (Plate 49 of Mr. Wiggin's paper). To get quick service, the Westinghouse pumps and a battery of two or three Canniff grouting machines were mounted on a car, together with necessary piping, etc. The tank machine has no rotating parts and is very quick in action, being stirred and discharged by compressed air.

It was soon found that the cut-off walls did not "cut-off," and that grout passed them rather freely, probably going through small fissures in the rock next to the concrete and between the concrete and the rock. After attempting to fill a few sections, using the cut-off walls, which in no case served their purpose, low points in the rock profile of roof were picked out and filled with grout, using pressures as low as 50 lb., it being found that higher pressures threw the grout too far and discharged too much air over the arch. After these stretches were set, the intermediate spaces were filled, using the low pipes until the highest ones overflowed. The high pipes were then cleaned, so that the last remaining spaces could be grouted under pressure. It was found that the pipes which opened to the rock below the top of waterway did not connect and could be grouted individually under higher pressures, but usually

took little more than necessary to plug them. This was due to the settling of the green concrete, which tends to pack against the rock below the top of the form and to shrink away above this level. It was found difficult to hold the grout under pressure above the arch, as the transverse joints, which occurred every 45 ft., had opened slightly, and leaked considerably when placed under pressure. This was rather unexpected, but it is not so much to be wondered at, as the concrete while setting probably rose to a temperature of over 100 degrees, while at the time the grouting was done (winter of 1909-10) it had fallen to about 50 degrees—enough difference to account for the opening found. The grout was usually mixed 1 cement to 1 very fine sand, by volume, the sand being of great aid in plugging joints and preventing the undue running of the grout. Even the 1:1 grout seemed to run freely for hundreds of feet, when first placed, so that almost any pipe leading to the top of the arch could be used for grouting and no sharp distinction between grout and vent pipes was necessary.

Great care was used in grouting the stretch between Shafts No. 5 and No. 6 (2 500 ft.), and the work was gone over several times until finally there remained no spaces to be filled with grout. Some of the high pipes were opened up repeatedly and re-grouted. The vertical joints in the wet stretches, despite every effort, still leaked slightly. Grout pads were used and holes drilled into them, grout pipes placed and attempts made to fill the joints. In very few cases did any grout leak through the body of the concrete, and these were in sections placed too dry at the beginning of the work. None of the wet, dense sections of concrete was penetrated by the grout.

In the next stretch grouted, between Shafts No. 7 and No. 8, advantage was taken of the experience gained between Shafts No. 5 and No. 6, and a very simple system of grouting adopted. The machines were started at Shaft No. 7 and the grout driven ahead, the normal pressure of 100 lb. in the air mains being reduced to about 50 lb. by a diaphragm reducing valve. The isolated pipes below the top of the waterway were plugged with grout, as the plant used pressures up to 250 lb. A few of the high pipes in the arch were opened and grouted, also at high pressure, but these took comparatively little grout. In this way rapid progress was made and the results were good.

METHOD OF USING VERTICAL SIGHTING INSTRUMENT FOR DROPPING CENTRE LINE DOWN SHAFTS.

Some sections of arch were cut into and the dry packing and space over the arch were found to be thoroughly filled. The set grout, 1:1 by volume, was found to be somewhat stratified, but nevertheless fairly dense, weighing 134 lb. per cu. ft. The stretch between Shafts No. 5 and No. 6 took 40 cu. ft. per lin. ft., and that between Shafts No. 7 and No. 8 the same. The dry packing was found to have 59% of voids which took grout.

We believe grouting to be indispensable and invaluable for this character of work; nevertheless, various theories were upset, the main one being that by means of the cut-off walls the tunnel could be grouted in short sections (about 50 ft.) under high pressure, the space behind the concrete being rapidly filled with liquid grout, which was to penetrate into all crevices, sealing up the rock so that the ground water would not even reach the lining, which, by this theory, is only a surface coat to provide a smooth waterway. Again, it was not found that high grouting pressures could be used to much advantage, nor do we believe that these pressures caused much circulation of grout in the body of the rock, merely plugging the holes leading to seams. This, I am sorry to say, rather upset the hope expressed by Mr. Wiggin that the tunnel would be tight independently of the concrete lining, under the supposition that all the porous spots in the rock and seams would be imperviously filled with grout. Again, the transverse joints proved to be troublesome, preventing the placing of any considerable body of liquid grout under pressure, and persistently leaking in the wet areas. The grouting, instead of being a process of impregnation under pressure, proved to be rather a silting-up process, the grout filling all spaces back of the lining and the voids in the dry packing with sand and cement, and plugging up springs leading to the vent pipes. It will probably be carried into the transverse joints by percolating water and gradually silt them up. I do not believe the grout will prevent the ground water from reaching the concrete lining, which, after all, must be the main reliance in keeping the water out when the tunnel is empty or when in service. For this reason, the concrete arch should be reasonably thick, so that the men can conveniently work behind the forms. Ten to twelve inches of rich, dense concrete, placed very wet and rammed in level layers, with all spaces behind grouted, will prove in time very tight, as the joints ought readily to silt up.

DISCUSSION.

JOHN P. HOGAN, M. M. E. N. Y.—This work is of particular interest as it is a great advance on former practice, not only in conception and design, but also in methods and speed of construction. For the first time progress was made in shaft sinking and tunnel driving which will compare favorably with western American and European records. At one time one of the headings on the Rondout pressure tunnel (No. 7 south) held the American record for tunnel in hard rock—488½ ft. in one month. This record was afterwards eclipsed in the Catskill aqueduct and the Walkill pressure siphon, and later has been exceeded in the West.

Mr. White has touched in his paper on the thoroughness with which the preliminary and exploratory work was done, but I think that this point can be still further emphasized. Not only were the borings unusually extensive and complete, but various tests were made by pressure and pumping experiments to determine the relative porosity and water-carrying capacity of the different strata. The linear feet of borings made exceed slightly the linear length of the tunnel. The expense of this work was high, but was justified by the seriousness of the problem, and so well was the work done, that now, when the tunnel is driven, there are practically no changes to make on the preliminary profile. It is the opinion of the writer that not a bore-hole was wasted.

Another experiment which was well worth while, was the excavation of the experimental drifts. A heavy bed of hard white grit, about 300 ft. thick, overlies the south end of the siphon. The problem was whether to drive the tunnel through this grit at a high level or through the softer shale at a lower level. It meant balancing the decreased cost and increased progress that might be made in the shale against 200 ft. additional depth of three shafts, and the only guide to be obtained to this was the records of the experimental drifts. The deductions made were very well substantiated later on by the records made by the contractor in driving through the material.

It is seldom that money is available for sufficient exploratory work in advance. Wherever there is any risk or uncertainty the contractor will allow for the same in his bid price, and a dollar spent before the contract is let will often save many in cost of construction.

There is one point upon which the author has touched lightly, which is highly creditable to him and deserves mention. That is the adoption in most cases of temporary timber in place of structural steel roof support. When it is considered that about

10 000 ft. of the Rondout pressure tunnel required support and that the temporary timber is from $30 to $40 cheaper per foot, the amount of this saving can readily be estimated. The temporary timber consists of an arch block and two rakers, wooden lagging, and, of course, it has to be removed before the concrete is placed. The structural steel roof support consists of steel arch ribs with steel angle or channel lagging. The temporary roof support was put in the contract largely on the author's suggestion, the original intention being to provide for nothing but the structural steel. Now, as it happens, the temporary timber is not only cheaper than the structural steel roof support, but very much better, and, in a case where you can substitute a cheaper thing that is better, it is a considerable achievement.

Now, wherever there is pressure the structural steel roof support is not heavy enough to resist the pressure, and it has inherent disadvantages in its design, because, where the roof is heavy and requires support, you want to provide as narrow a drift as possible, but with the structural steel roof it is necessary to drive the tunnel two feet wider than your maximum section, and it has to be excavated full width before you can get a single rib in to support anything. For light ground, the temporary timber is not only cheaper, but it is a good deal easier to put in. For heavy ground, the structural steel roof support is not strong enough. We have 136 ft. of structural steel roof support in place which failed under pressure, and had to be supported by temporary timber bents, and we are now trying to work out a scheme by which we can take out the timber without having the structural steel roof support come down on us.

The reason for the use of structural steel roof support is that it is believed it will give some advantage in lining the tunnel. That is, when once in it will stay there and the tunnel can be lined easier, but we are now removing the temporary timbering without any delay in lining the tunnel. It simply means having an additional set of forms; that is, where the contractor would use ordinarily three sets of forms at one point, we are now using four.

I mentioned that the tunnel was a great step in progress over other Eastern tunnels. Numerous records have been made in the West of 300 and 400 ft. per month, but it was not common in the East to make such speed. Now, as the author said, the question of speed in tunnel work is largely a question of organization, the rock conditions being the same. There has been great discussion in the engineering papers in regard to speed of driving tunnels and the reason for it, and a number of unfavorable comparisons have been made of American records with European records. But it seems to me that the advance that has been made on this tunnel

has been due largely to better organization and to a better personnel. It is largely a question of having a large number of experienced tunnel workers to draw on.

Another thing that has kept the American records lower than European records is the question of cost. Tunnels here are driven in the most economical manner, and additional money is not spent on getting additional speed. That is, the speed is as fast as is consistent with economy, and I do not believe it possible to drive a tunnel of that size and shape much faster and do it in as economical a manner.

I think it is well established that, when you take your time and do enough work, you can make the headings meet with any degree of precision you wish. In a railroad tunnel it is very necessary to have the tunnel driven to a very good line, and especially in a shield-driven tunnel, where it is necessary that the shields should meet very closely. In a pressure tunnel like the Rondout tunnel, the tunnel may come up and down and in and out, it does not make any difference. The water is under pressure, anyway, and will flow through under any conditions.

It was decided, before the driving of this tunnel was started, not to attempt to get a very accurante meeting; that is, not to attempt to do any extra work to make the tunnels meet with any great degree of precision, because a foot would be close enough. When the headings met there would be about 400 ft. of unexcavated bench, and it would be possible to make any adjustment necessary. As a matter of fact, I believe that on the average lines were dropped only four times in these shafts, and yet most of the headings met with less than an inch error in line and grade. The greatest error of alignment was 8 in., which was within the limit of 1 ft. set before the work was started. Any additional time and money spent in getting a greater degree of accuracy would not have been justified, as it would have served no useful purpose except to increase the personal satisfaction of the men doing the work.

One of the first principles of surveying is to have in mind before you start the results you wish to obtain and to do no more work than is necessary to attain these results.

Robert Ridgway, M. M. E. N. Y.—The Rondout pressure tunnel, described by the author of this paper, is the most difficult piece of work the Board has undertaken to construct. I have said that a number of times and am more than ever convinced of its truth. Notwithstanding the talk that has been indulged in about the difficulties of driving our Hudson River Tunnel, I believe it to be a simpler proposition than constructing the Rondout pressure tunnel. In spite of the difficulties encountered in the latter,

the excavation is now completed and over sixty per cent. of the concrete lining is in place. This gratifying condition is due to the intelligent and energetic manner with which The T. A. Gillespie Company, contractors, have taken hold of the work.

The most notable structures that the Board of Water Supply has undertaken to design and construct are the deep pressure tunnels, of which the one described by the author is an example. Their prototype is the Harlem River siphon tunnel of the New Croton aqueduct which he has mentioned. That tunnel is seven miles long, and extends from a point about a mile north of the Jerome Park Reservoir to the One Hundred and Thirty-fifth Street Gate House. It was a subject of much discussion when it was designed, over 25 years ago. Mr. E. Sherman Gould, a noted hydraulic engineer of that time, spoke of it as a far bolder proposition than the great dam, planned to be built across the Croton River, near Quaker Bridge. The tunnel has been in service now for twenty years, and, so far as I know, has not given any trouble at all. It has never been pumped out, and the water flows freely through it to the distribution system below. Mr. Fteley, Chief Engineer of the work, in a report to the Aqueduct Commissioners, estimated the loss from this seven miles of pressure tunnel, after it was put in service, as something like 228 000 gal. per day, a negligible amount. I think the same length of open-cut aqueduct, with no pressure at all except the depth of water in it, would leak considerably more than that. Of course, there is no such pressure in the Croton pressure tunnel as we have to deal with in our Catskill pressure tunnels. In the former, the deepest part is about 400 ft. below hydraulic gradient, and there is a maximum unbalanced head of about 135 ft. At the Hudson River crossing of the Catskill Aqueduct the tunnel will be 1 500 ft. below hydraulic grade, and the unbalanced head will be about 400 ft. In spite of this enormous pressure we feel confident, from the careful studies that have been made and the conditions known to exist, that the tunnel will do the work planned for it.

Mr. White spoke of the payment line for the New Croton Aqueduct tunnel excavation. I was connected with that work. The contract specifically stated, as I remember, that payment would be made for the excavation to a certain line indicated on the contract drawings. During the progress of the work the contractors made claims for additional excavation outside of this line, and convinced the Aqueduct Commissioners that they were entitled to it. It was decided to pay them in places for something like 8 in. outside of the cross-section originally ordered. This additional amount was carried along in the estimates for a number of months. Following a reorganization of the Board, the new members of the

Commission looked into the matter and decided that the contractors were not entitled to the increased amount, and it was accordingly taken out of the estimates. The contractors naturally protested, and, I believe, this was one of the grounds for the suit they later brought against the City for extra work. The courts, however, sustained the City's side of the case. The method of fixing the payment lines adopted by the Board of Water Supply on Designing Engineer Wiggin's recommendation is a better and more equitable one. A line is fixed called the "A" line, within which no point of rock may project. Outside of this is the "C" line, which represents the average effective thickness of the masonry lining. Farther out is the "B" line, or payment line. It is manifestly impossible to excavate a rock tunnel exactly to any prescribed line, and this method of give and take is a practical solution of the problem. The contractor is paid to the "B" line for his excavation and masonry. With good management he can frequently keep his excavation inside of that line, and there is thus an incentive for him to drive a good tunnel section.

Henry W. Vogel, M. M. E. N. Y.—I think that most of us have read in the newspapers, since our last meeting, that there was quite an unusual blast in the Hudson River siphon, and that a crevice was started. If it is a fair question, I will ask Mr. Ridgway to respond.

Robert Ridgway, M. M. E. N. Y.—In driving the tunnel west from the foot of the East Shaft, at an elevation of 1 100 ft. below tide water and a distance from the shaft of 270 ft., a crevice was encountered, yielding an inflow of water of about 200 gal. per min. At the time the heading was so close to the shaft that permanent pumps had not been installed for fear the blasting would injure them, and only temporary pumps were in use. Consequently, the water gave us more or less trouble. It gained for a time, but the tunnel was finally emptied. Now the permanent pumps are in place and the water is under full control. The 200 gal. encountered here seems small when compared with the 2 000 gal. which The T. A. Gillespie Company pumped for a while from Shaft 4 of the Rondout pressure tunnel without any fuss. The inflow there has now been reduced to about 1 250 gal. per min., which is still quite a respectable amount. In spite of this inflow, one can go into Shaft 4 and not realize that so much water is being pumped, so well equipped is the plant for handling it.

There will doubtless be more water-bearing crevices encountered in driving the remainder of the Hudson River Tunnel. The granitic gneiss to be traversed, however, is of such a character that we do not expect the trouble from water that was encountered in driving through the porous rock of Shaft 4 of the Rondout tunnel.

Regarding the latter, it was a grave question in the minds of some before the contract was let, whether the tunnel could be driven through this water-bearing rock. It was known that a large body of water was there, but how much no one could tell. The fact that the tunnel was driven there so successfully is an additional reason for encouragement in the driving of the Hudson River Tunnel.

THOMAS C. ATWOOD, M. M. E. N. Y.—The speaker has always felt a great deal of admiration for the way in which the design and construction of the Rondout pressure tunnel was conceived and carried out, both by the engineers and the contractors. The design was presented before this Society by Mr. Thomas H. Wiggin, M. M. E. N. Y., on October 27, 1909, and now the construction is described to us by Mr. White, who had the responsible charge of the work in the field.

Throughout the length of the aqueduct the pressure tunnels have perhaps been given more study than the other portions, as they were the most novel and bold construction, pressure tunnels having been used to only a slight extent before. Consequently, the construction of the Rondout tunnel, the first of the pressure tunnels to be put under contract, was watched with much care, and the successful completion of the excavation and complete assurance that the tunnel will be lined and finished up in good shape is a matter of great satisfaction.

Too much emphasis cannot be placed upon the difficulties encountered in the tunnel north of Shaft No. 4, nor the persistence and skill manifested in overcoming them.

The speaker visited the tunnel when the water encountered was at its worst. All the drill holes in the heading were spouting full-sized streams of water charged with hydrogen sulphide gas. The photograph shown does not give an adequate idea of the quantity. The gas affected the eyes of the men badly, although large quantities of fresh air were constantly supplied. Under these circumstances the fact that the work was pushed through without serious interruption is a striking proof of the courage and peristence of the men on the job.

With this example behind us, we expect to carry through the eighteen miles of pressure tunnel within the City limits just as rapidly and successfully. The rock within the City limits is not expected to yield gas or large quantities of water; but should these or similar difficulties be encountered, there can be no doubt that they will be overcome and the work successfully completed.

HERBERT M. HALE, M. M. E. N. Y.—The author has mentioned the method of getting the lines down the shaft. Aside from the construction features and the method of tunnel lining, this is, perhaps, the feature more particularly interesting as tunnel engi-

neering. There were two methods used. Of course, the old method of the wires is all right if nothing disturbs the wire setting even slightly, but in the Rondout tunnel the shafts were very narrow, with the allowable base line within the shaft only 7 ft. 2 in. in length. It was this short base line that had to be continued toward the adjacent shafts. The spacing of the shafts ranged from 2 000 to 4 400 ft.

I regret to say that the transit method was not fully developed before all the headings were holed, but I hope to see that method tried further by the engineers of the City Aqueduct tunnel. I think the idea of using two independent methods to get the lines into a tunnel is a good one. It eliminates a great many of the difficulties and uncertainties arising from too many attempts to get line with wires alone. Great credit is due Mr. Charles Goodman, M. M. E. N. Y., for many of the details of the shaft transit method as developed in the Rondout siphon.

A MEMBER.—Do you think that method could be used in the Hudson River shafts?

HERBERT M. HALE, M. M. E. N. Y.—It can be used, I think, at that depth. It is only a question of having the illuminated sights in the board sufficiently bright, and, of course, it is needless to say the shaft must be reasonably ventilated, and thus quite free from smoke or haze. In these tunnels ventilation was a feature, and the shafts could be cleared by drawing air downward. Too much water dripping down the shaft might form a mist, which could not be thrown off by ventilation, yet a considerable amount is required to make the method impossible.

Either stick to the wire method alone and do it a great many times, or else try the two independent methods, requiring the use of the shaft a less number of times, and get results that check within the allowable clearance of meeting of the headings. We found on the Rondout siphon with the short shaft base, that a meeting of headings anywhere inside of a foot might be expected with careful work. Continued line dropping with a view to any closer meeting is a refinement quite unwarranted.

CHARLES GOODMAN, M. M. E. N. Y.—The method of using the vertical sight transit is a very good one, in that it gives you an independent dropping of the line down the shaft, taking a line from the surface with the transit and carrying it into the tunnel in one operation, then repeating again and again, each operation being entirely independent and checking the others. About 40 droppings in an hour have been made. There are no mechanical features which require data from the intermediate stages to make sure that you have got a line in the tunnel that is approximately correct. A clear shaft with no fog is essential to the success of the vertical sighting.

In averaging up a number of line droppings from shafts 350 to 600 ft. deep, both wet and dry, and comparing them with a number of wire droppings after the tunnel lines met, I regret to say that the wire droppings averaged much better. That is, it seemed to me that you could drop wires between the 7 ft. base in the shaft with an error of less than .01 in 100 ft., whereas the other method gave about .02 in 100 ft. As Mr. Hale has said, however, the method is being developed, and I do not think it is yet in a finished state. In any case, the vertical sighting method gives a line which is very nearly correct and allows little chance for carelessness to enter into the work.

LAZARUS WHITE, M. M. E. N. Y.—I avail myself of the customary privilege, granted by this Society, of saying the last word, with the comforting assurance that being the last word nobody can contradict or gainsay what I say. Mr. Hogan has very kindly credited me with effecting a great saving in the construction of the Rondout siphon through the use of temporary timbering instead of structural steel. In such a large organization as that of the Board of Water Suply no one man, unless it be the Chief Engineer himself, can do much alone. Were not my recommendations for the temporary timbering, as used first in the experimental tunnel in Hudson River shale, adopted by Department Engineer Ridgway and the designing engineers, and shown by them in the contract drawings, little would have come of it. Even then it required considerable courage and faith on the part of the contractors and the engineers directly in charge of construction to use it. Later our faith was justified, as nearly all this timbering has been successfully removed and the roof is now solidly supported in most cases directly by the concrete arch, and in a few others by dry packing. I believe, also, that by the use of a little longitudinal steel over the temporary timber bents bad places in the tunnel roof can be passed without the danger or trouble of removing the falls of rock which sometimes occur when removing the simple type of temporary timbering. The method of supporting the very heavy ground between Shafts No. 3 and No. 4 is an enlargement of this idea.

The actual work of sinking at Shaft No. 4 and driving the tunnel at its foot has been so thoroughly described by Messrs. Hogan and Wait that little more can be said along that line, but considerable discussion has arisen over some historical aspects of this famous shaft. Late in the fall of 1908 the tunnel was flooded by an inrush of water from the Binnewater sandstone and the pumps were overwhelmed. By purchasing and installing a new outfit of large Cameron sinking pumps, the shaft was recovered, but later repeatedly flooded, so that it seemed hopeless to try to get down without a change of method. About Christmas of that year Mr. James T.

Sanborn, M. M. E. N. Y., Division Engineer, visited High Falls expressly for the purpose of recommending the cementation process and had with him articles showing its successful use in France and elsewhere. Mr. Sanborn recommended drilling through the water, filling the shaft to the porous strata below, and then, through pipes sealed into the rock, pumping cement grout into the porous layer, draining the shaft and then resuming sinking. This was explained and strongly recommended by me to the contractor's superintendent, Mr. Robert A. Shailer. Mr. Shailer, however, rather underestimated the water in the rock, and chose to try to pump the shaft down. Early in 1909 it was seen that the pumps could not cope with the water, after great quantities spouted out of the drill holes which penetrated to the main water-bearing seam of the shaft. Pipes were inserted in these holes, calked with wooden wedges driven between them and the rock, and the water controlled by gate-valves a foot or two from the shaft bottom.

Mr. Thos. H. Wiggin, M. M. E. N. Y., Senior Designing Engineer, then returned from Michigan, where he had made an extended trip to inspect the copper and iron shafts of that region. At a division engineers' meeting in Poughkeepsie, he described the sinking of the Detroit salt shaft by Mr. Bradt, and recommended that similar methods be used for Shaft No. 4. The methods at the Detroit shaft were very similar to those intended to be used at Shaft No. 4 by the contractor upon the recommendation of the engineers, and the success of Mr. Bradt, as described by Mr. Wiggin, did much to encourage the writer to persist along these lines. Mr. Bradt's method of wrapping the ends of grout pipes with a cone of flannel, as described by Mr. Wiggin, was adopted, and replaced the method of driving wooden wedges alongside of pipes to secure water-tightness at top of rock. We owe much to the encouragement given us by Mr. Wiggin's description of the tremendously wet and difficult sinking of the Detroit shaft, but I must reiterate that the methods used at Shaft No. 4 were well known long before Mr. Bradt sank that shaft, and that the credit is due, not to any unique or patentable method adopted here or elsewhere, but to the courage, energy and persistence of the contractors, the T. A. Gillespie Co., in following well-understood practices and employing all the resources of modern machinery and the most skilled superintendence and labor to be found, and let me also add that the engineers of the Board of Water Supply in direct charge gave them all the assistance and encouragement in their power.

It has long seemed an anomaly to me that although we could prolong a short base line projected down a shaft with great accuracy by means of an ordinary engineer's transit and vertical wires, no use was made of this telescope to get lines down

shafts, although offhand this would appear to be far simpler, for the process is the reverse of the one usually used—a long surface base to project a short shaft line vertically downward. As we had a great many shafts along the Catskill aqueduct, it was deemed worth while to obtain a vertical sighting transit. Mr. Sanborn followed this up for us and succeeded in getting a very fine instrument from C. L. Berger. This was not a new design, but was made up from old parts. In only one respect would I suggest a change. At present it is not firmly fixed laterally on the wyes, so that a little pressure sideways is likely to throw it out of line. It would be a simple matter to add a set-screw or some device to prevent this, in which case we could obtain even better results. Mr. Hale described the method of using the vertical sighting transit very fully in *Harvard Engineering Journal,* and I merely show here Plate 56, which fully explains itself. Personally, I was much pleased with the results obtained by Mr. Goodman, and believe that this instrument, by giving an absolutely independent check on the tunnel line, has justified itself and saved the endless and costly repetition and worry usually indulged in by the engineers when the wire method alone is used.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 66.

PRESENTED SEPTEMBER 27TH, 1911.

THE CITY PLAN AND WHAT IT MEANS.

BY NELSON P. LEWIS,* M. M. E. N. Y.

WITH DISCUSSION BY
EDWARD M. BASSETT, ARTHUR H. BLANCHARD, GEORGE W. TUTTLE,
ROBERT R. CROWELL, WILLIAM G. FORD, AMOS L. SCHAEFFER,
ARTHUR S. TUTTLE, HENRY W. VOGEL, AND
NELSON P. LEWIS.

We have heard a great deal lately about what is called city planning. Everything relating to municipal affairs has been very fully discussed, including accounting, budget-making, 100% efficiency, commission government, and many other things which might be classified as ideas or idiosyncrasies, as facts or fads. City planning has been the subject of local, state, national and international conferences, conventions and exhibitions, has been discussed in lectures, newspapers, periodicals and books, and one quarterly publication is devoted exclusively to this subject. Such evidences of public interest could not well have been manufactured by those having some selfish interest to promote, but it seems quite clear that the public is becoming greatly interested in the subject. It cannot, therefore, be dismissed as a fad or as a matter that appeals only to theorists, but we must recognize it as something

*Chief Engineer, Board of Estimate and Apportionment.

real and vital to the proper growth of our cities. In this paper an effort will be made to discuss the following questions:

1. What does city planning mean?
2. What are its economic advantages?
3. What progress has been made in city planning in this and other countries?
4. Who should be responsible for the city plan?
5. What general principles should govern city planning?

First, then, what is it? It is simply the exercise of such foresight as will promote the orderly and sightly development of a city and its environs along rational lines, with proper regard for the health and convenience of the citizens and for the commercial and industrial advancement of the community. It does not mean what has been so often called the "City Beautiful." It does not mean or even include municipal art, nor does it in the author's opinion include the architecture of public or semi-public buildings.

A city planned in accordance with the principles laid down in the above definition will surely become beautiful; it will lend itself to artistic treatment (not adornment by municipal art, for it is difficult to explain in what respect "municipal" art differs from any other kind of art); it will provide adequate sites for public and semi-public buildings which can be availed of by the architect when the time comes without the expense of rearranging the street system to give them a proper setting. To plan a city with its final artistic embellishment would be not only folly, but would be far beyond the capacity of any one man or group of men in any one generation. To attempt to designate the specific sites for future public buildings with a special regard to the size, shape and design which those making the plan deemed to be most suitable, would evidence an arrogance and self-complacency which would render one unfit for the task he has undertaken.

Reverting to our definition, the planning should include not only the city but its environs; that is, it should bear some relation to the neighboring cities and the rural and small urban districts which are within easy reach. Every city is supported to a large degree by the country behind or about it. The idea that every effort should be made to confine its working population as far as possible within the

red lines forming its boundaries is a fallacy having its origin in the selfishness of those who wish to maintain realty values within the city at as high a figure as possible. The object should be to reduce to a minimum the resistance to both intra- and inter-urban traffic. This applies not only to ordinary street traffic, whether by vehicles or surface railways, but to steam and electrically operated railroads for the transportation of passengers and freight. The idea that railways are an evil which must be tolerated, but that they should be kept out of sight and should be compelled to carry on their business almost surreptitiously, is a grave mistake. A city cannot live, much less grow, without them. Our city plan must, therefore, provide not only direct and ample thoroughfares for vehicular traffic and routes for the transportation of passengers to and from their homes within the city, but it must take into account the vital necessity of railway lines and terminals for the economic and expeditious handling of passengers and freight in such a manner as to reduce so far as possible the time and expense of transportation to and from home, office, shop or factory, from and to points outside the city.

Thoroughfares should be both radial and circumferential. In every great city there is always one centre of the first importance, with a number of minor centres. The great radial thoroughfares will necessarily converge at the principal centre, with minor radials reaching the subordinate centres, while the circumferential thoroughfares will connect the less important centres with each other and make it possible to go from one to another or to the suburbs without passing through points or districts of traffic congestion. The plans suggested almost simultaneously by Sir Christopher Wren and Sir John Evelyn for the rebuilding of the central portion of London after the great fire of 1666 illustrate this idea, but unfortunately neither plan was carried out. It is also shown by the diagrams of radial and circumferential streets included in the report of the Metropolitan Improvements Commission of Boston, which shows how many links in such a system often exist and how relatively simple a matter it is to supply the omissions. If New York had possessed such thoroughfares, how much simpler would be the solution of the transit problem with which the City has been wrestling during recent years.

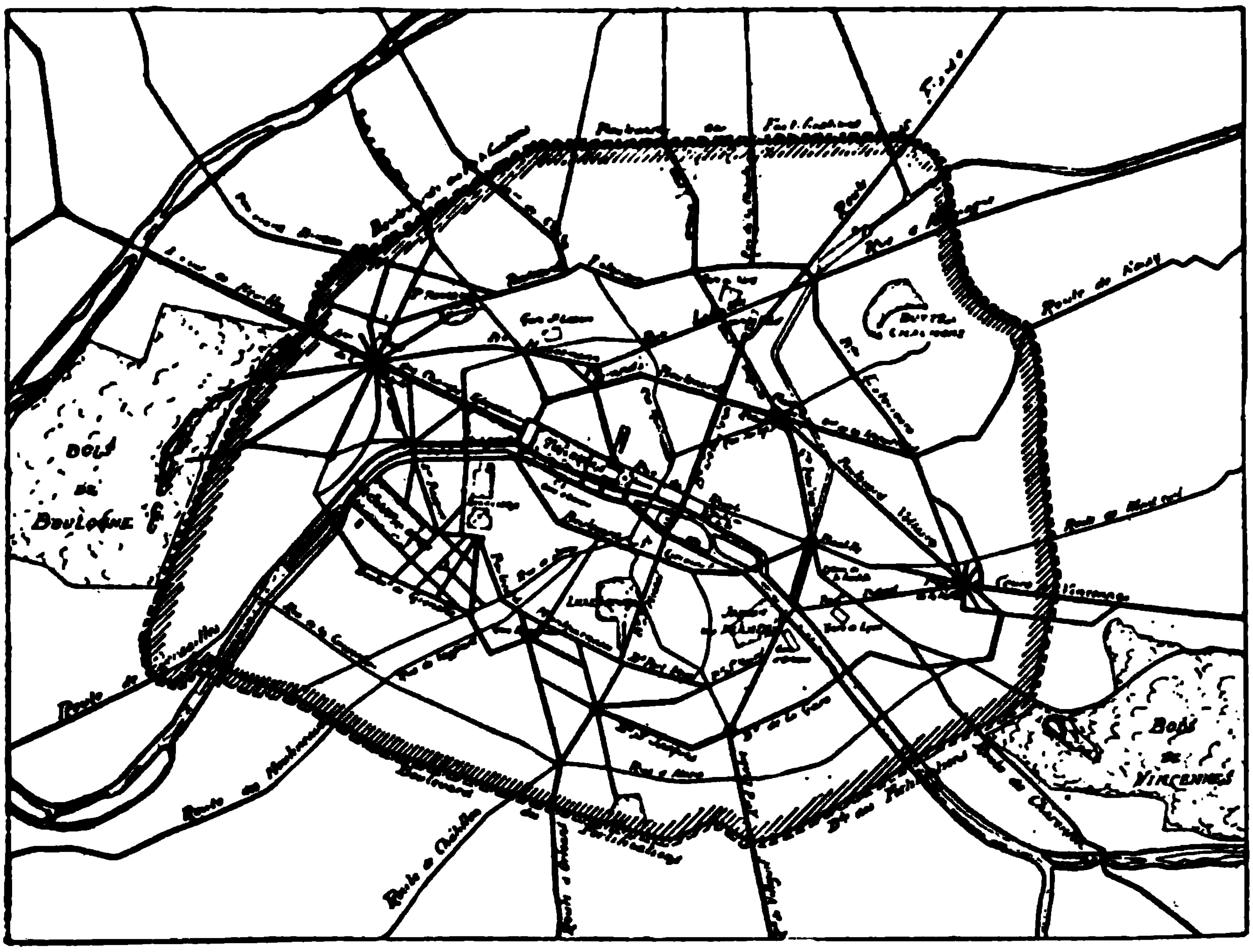


FIG. 1.—PLAN SHOWING TRAFFIC CIRCULATION OF PARIS.

This diagram shows the admirable system of radial and circumferential streets with several well-defined focal poiuts. Reproduced from "Town Planning," by H. Inigo Triggs.

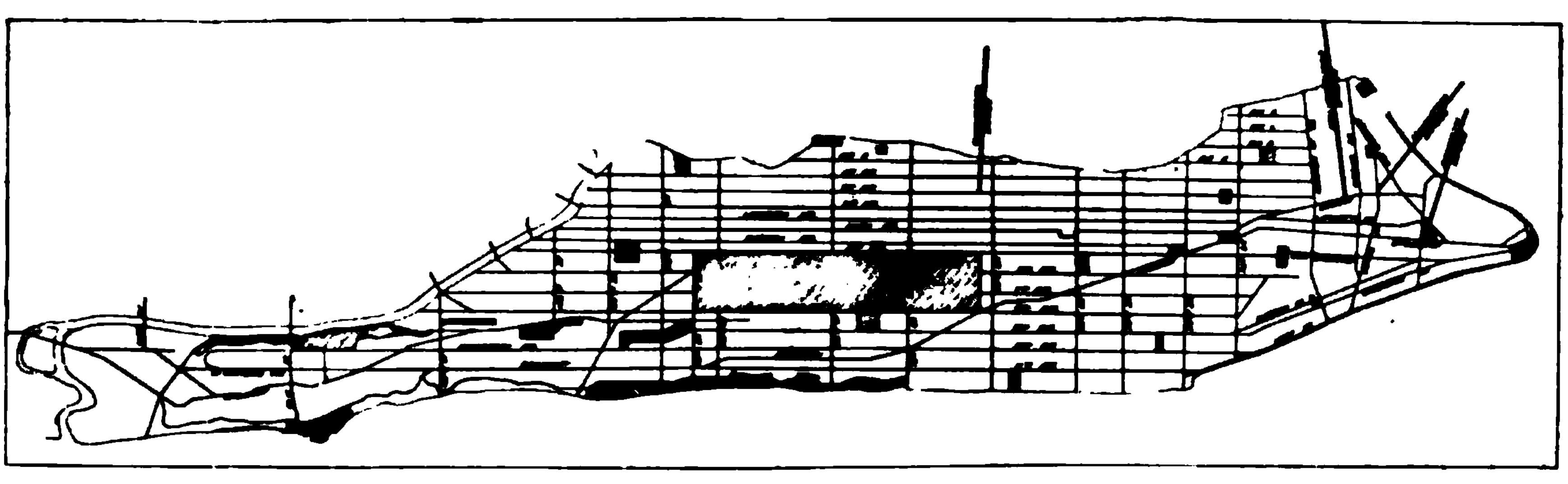


FIG. 2.—PLAN SHOWING THE MAIN TRAFFIC STREETS OF THE BOROUGH OF MANHATTAN, CITY OF NEW YORK.

Shaded areas indicate parks.

This plan shows the serious lack of diagonal thoroughfares. which it was practically impossible to secure owing to the peculiar shape and the restricted area of Manhattan Island. Such a plan is necessarily deficient in proper sites for public buildings.

Regard for the health as well as for the convenience of the citizens requires that there shall be ample provision for open spaces for recreation and amusement. In other words, that there shall be within easy reach of every home a park where the occupants of that home can find fresh air and out-of-door rest or play. This does not mean that the parks must necessarily be large or that they should be highly developed by the landscape architect, or that they shall be located upon most expensive property. There are many tracts of land of varying sizes which are passed over by the real estate operator as unsuitable for development and the cost of which would be very small, but which if secured and held would become extremely valuable to the public as parts of the park system of the future city. Nor need they be developed for years to come. A piece of natural woodland, a creek bottom now little more than a swamp, a rocky ridge or steep slope which is unavailable for building purposes, can often by the building of a few paths or drains be made to serve their purpose as playgrounds at slight expense. The important thing is to secure them while they are still cheap, with the right to dispose of or convert to other uses such portions of them as may not be desirable for park purposes when the city plan is finally developed. The idea which seems to have controlled the park policy of New York and many other cities is that parks shall be located and purchased only when the actual need for them is developed, but meanwhile property has been converted to other use and has been covered with improvements, the destruction of which, as well as the enhanced value of the land and the disarrangement of the street system, would make the cost of the park so great that the project has to be either abandoned or curtailed. The cost of parks secured under a more rational plan, including loss of taxes and carrying charges, would be far less than under the policy prevailing in New York, while if acquired in accordance with a plan which will be outlined later, they can readily be made to carry themselves.

There is one other element in our definition of a city plan, and this is fundamental, namely:

The city plan, as the expression is used in this paper, is not a map "showing the parks, streets, bridges and tunnels and approaches to bridges and tunnels as heretofore laid out, adopted and estab-

lished pursuant to law," etc., but it is the general plan of arterial streets and transportation lines by which the different sections of the existing and the future city will be connected with each other and with centres of population outside the city limits; the parks and open spaces and other resorts for recreation and amusement; the existing waterfront development and the space needed for its further increase; existing public and semi-public buildings and sites for those which may be required in the future. This is the real city plan which will control future city development, stimulating it or retarding it, as the case may be. The block dimensions and angles, the widths of minor streets and the subdivision into a vast number of rectangular blocks of standard size, with an explanation of or an apology for every departure from that standard, do not constitute a city plan, the Charter of the City of New York to the contrary notwithstanding. The city plan is something bigger and broader. It is something to which the city may grow, not something to which it must be restricted or within which it must be confined as in a strait-jacket.

The economic considerations which should control the city planning are precisely those which should prevail in the design of a house, shop, railway terminal, or water-supply system, namely, adaptation to probable or possible increase in demand and capacity to supply that demand. If the manufactory or the railway is foreordained to failure, the less spent upon it the better. There are a few towns which were laid out during "boom" periods on lines which were fancied to be those of a future metropolis, where the broad streets are grass-grown, where the public buildings are but half occupied, and where everything speaks of a splendid ambition which resulted in grotesque failure. When a city occuping a strategic geographical position has begun a natural development which causes growing pains, indicative of a misfit in its general plan, it is time to look toward the future to adjust the plan to new conditions and to provide for still further growth. To tear down and enlarge is very costly, especially so when there is no room for enlargement without the purchase of additional land which has become far more valuable than when the original enterprise was begun. This is constantly being done by individuals and corporations whose domestic or business requirements make it necessary.

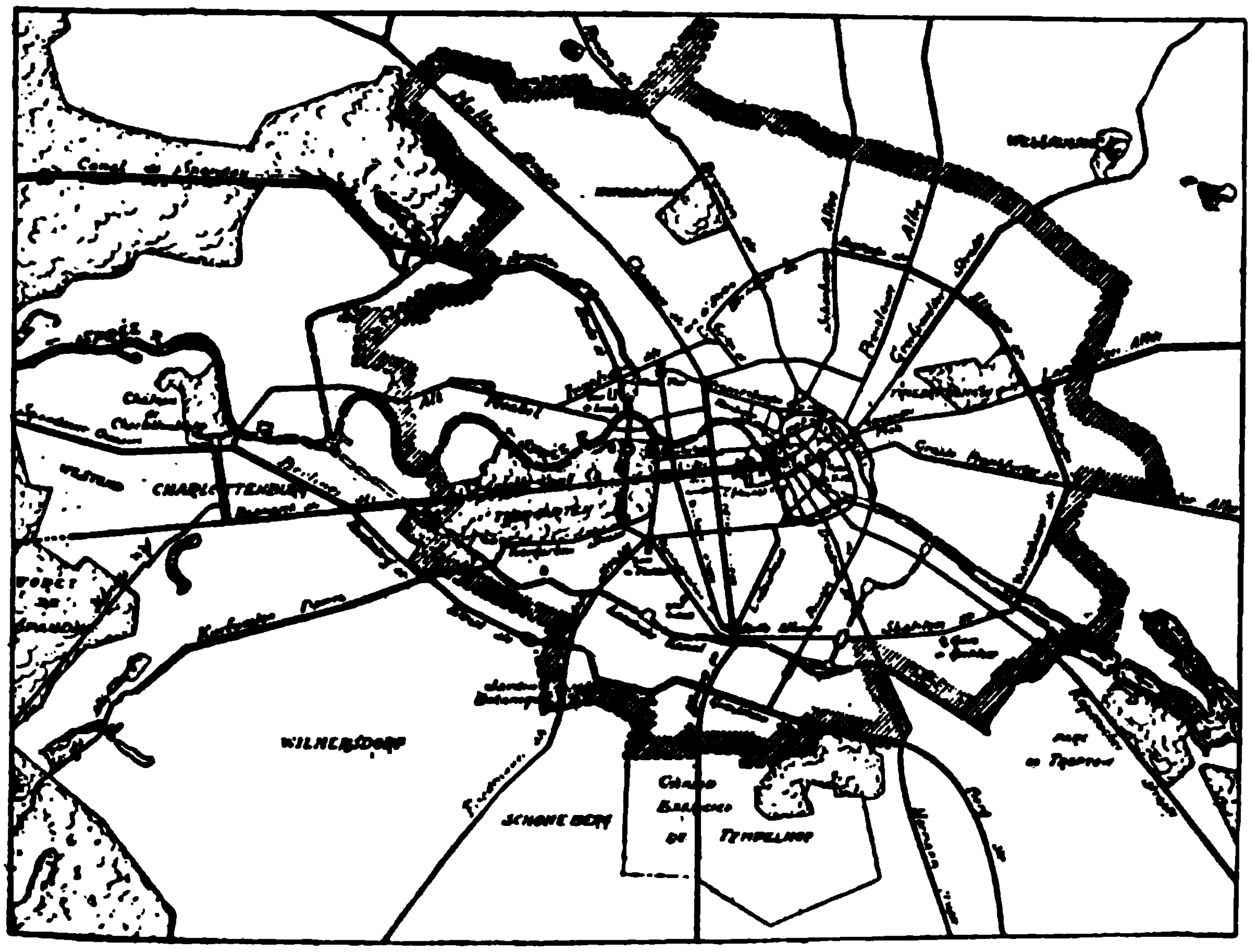


FIG. 1.—PLAN SHOWING TRAFFIC CIRCULATION OF BERLIN.

The provision of circumferential thoroughfares and of radial streets extended to and beyond the city limits is a conspicuous feature of this plan. Reproduced from "Town Planning," by H. Inigo Triggs.

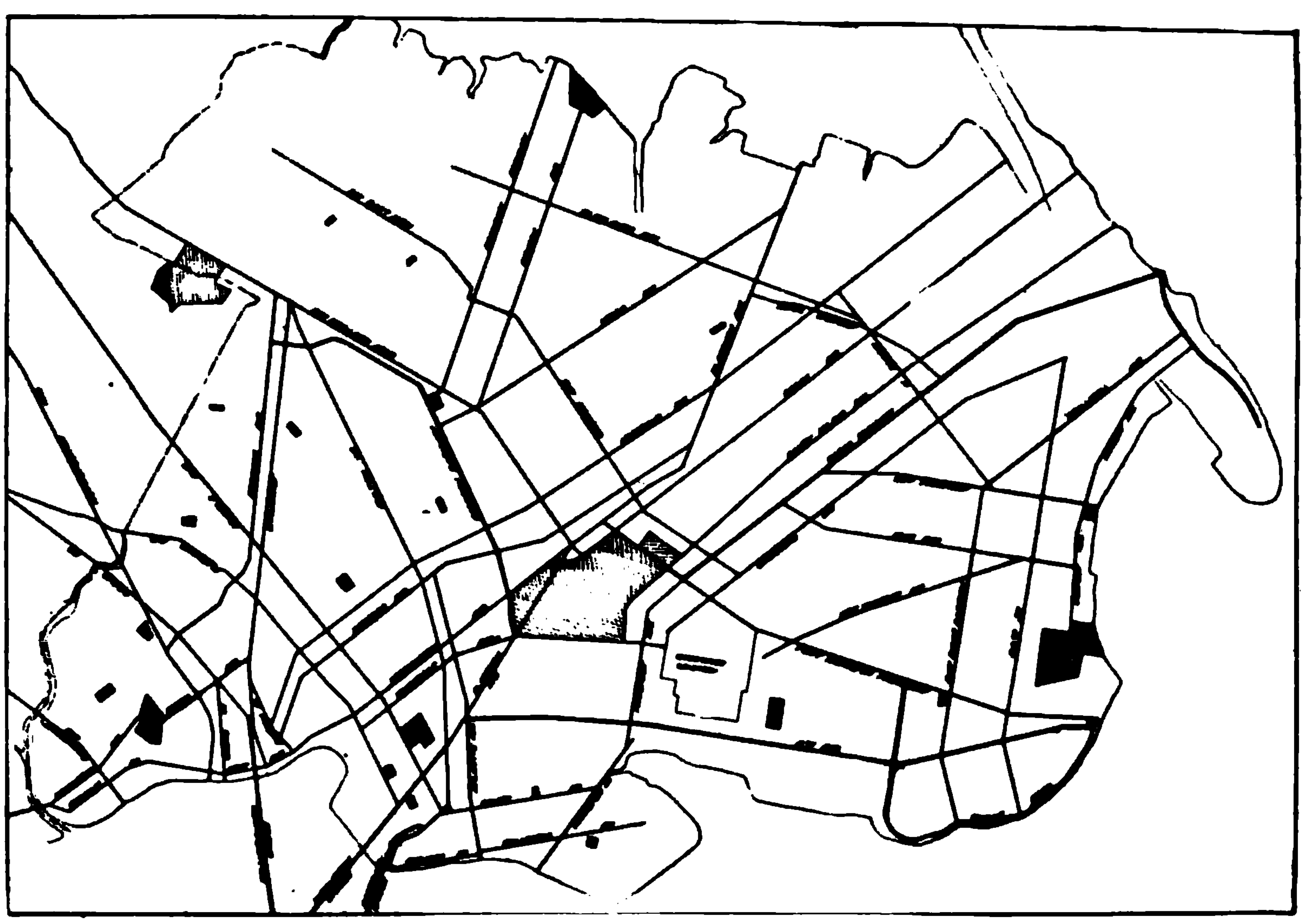


FIG. 2.—MAIN HIGHWAY SYSTEM OF THE BOROUGH OF BROOKLYN, CITY OF NEW YORK.

Shaded areas indicate parks.

A fair system of circulation would have been provided by this plan were it not for the lack of important focal points, and for the fact that the importance of most of the main thoroughfares is sacrificed by the location of two or more such streets in close proximity to and almost parallel with each other.

In every case it involves a distinct loss which may be justified by means to indulge in a luxury or by the prospect of increased profit. Cannot the city, it may be asked, instead of trying to provide for the remote future, well afford the expense of reconstruction to adapt itself to its growing needs, especially when it has the power, through its ability to levy taxes and assessments, to impose the cost of the necessary changes upon the property which will be chiefly benefited? No expense involving the destruction of property can be justified if it can be avoided by the exercise of reasonable forethought, and the taxing power of the city should not be used unnecessarily. The requirements of the modern city are so great that the burden of taxation will inevitably be heavy. Improvements in the city plan may increase values to such a degree that they would be cheap at almost any price, but if the plan can be so made as to avoid the necessity for destructive changes, both the city at large and the individual property-owner will be the gainers. To defer the correction of mistakes which are quite apparent in well-developed sections of the city or to put off the adoption of a broader policy in those in process of development because land is expensive and costly improvements would be destroyed, is not unnatural, even though it be unwise. To fail to take advantage of such object lessons in parts of the city where there are few, if any, improvements, or where the street plan has not yet been fixed, is the height of folly. The Borough of Manhattan furnishes numerous instances of changes manifestly desirable but deferred until their cost has become prohibitive. To show the money value of a good plan, not by forcing exaggerated values at some points, but by stimulating a healthy growth, through ease of access to all sections of the City, to schools, libraries, museums, parks and playgrounds, it is only necessary to examine the successive annual assessment rolls of districts so favored. One specific instance will be given. During the sixteen years following the laying out of Central Park, the average increase in the assessed value of real estate in other parts of the then City of New York was about 100%, while in the three wards then adjoining the new park, the increase was approximately 800%. Increase of population means almost invariably increase in wealth and taxable values. The most notable increase in urban population during the last quarter of a century has been in Ger-

many. A comparison of the rate of growth of six American and a like number of German cities during the last thirty years will bear out this statement. These cities were selected at random by the author some years ago, simply because they had about the same population in 1880 and because they were believed to be typical. The increase by decades is shown in the following table:

	Population, 1880.	Population, 1890.	Per cent. increase in 10 years.	Population, 1900.	Per cent. increase in 20 years.	Population, 1910.	Per cent. increase in 30 years.
Cincinnati	255 139	296 309	16.1	325 902	27.7	364 463	42.8
Breslau	272 900	335 200	22.8	422 728	54.9	510 929	87.0
Buffalo	155 000	255 664	65.0	352 387	127.1	423 715	173.4
Cologne	144 800	281 800	94.6	372 229	157.0	513 491	254.6
New Orleans	216 000	242 039	12.0	287 104	32.8	339 075	56.9
Dresden	220 800	276 500	25.2	395 394	79.0	546 822	147.1
Louisville	123 758	161 005	31.0	204 731	65.4	223 928	80.9
Hanover	122 800	163 600	33.2	235 666	91.0	302 384	146.2
Providence	104 850	132 099	26.0	175 597	67.5	224 326	113.9
Nuremberg	99 519	142 523	43.2	261 022	162.3	332 539	234.1
Rochester	89 366	133 896	49.8	162 608	82.0	218 149	144.1
Chemnitz	85 000	138 955	63.5	206 584	143.0	286 455	237.1

	TOTAL POPULATION OF CITIES.		INCREASE.	
	6 American.	6 German.	American	German.
1880	944 113	945 819		
1890	1 221 012	1 338 578	276 899 = 29.3%	392 759 = 41.5%
1900	1 508 329	1 893 623	287 317 = 23.5%	555 045 = 41.5%
1910	1 793 656	2 492 620	285 327 = 18.8%	598 997 = 31.5%

Increase of total population of United States, 1900 to 1910, 21%.
Increase of total population of Germany, 1900 to 1910, 16%.

It is generally conceded that the most scientific, painstaking and far-sighted city planning done in recent years has been in Germany. While it may have been commenced for reasons somewhat sentimental and because of a striving for that beauty which had proved a valuable asset in the Latin countries, it has been continued because it was found to pay, and the German cities are fast becoming the most beautiful, the most orderly and the most prosperous in the world. This is not a mere coincidence, but the conclusion is justified that scientific planning will promote to a greater degree than has heretofore been realized, not only orderly development, but increase in population, wealth and taxable values,

to say nothing of the convenience, health and comfort of the citizens. Many of the European cities have on account of their antiquity one great advantage in working out an admirable plan. A serious impediment to their growth has been the old fortifications within which the ancient cities were confined. It was fortunate for them that before they felt it safe to destroy the old walls and moats they had come to a realization of their value in affording sites for a splendid system of circumferential boulevards and open spaces. Perhaps the most conspicuous instance of this use is furnished by Vienna, whose superb Ring Strassen, occupying the spaces formerly devoted to the inner and outer fortifications, with its effective grouping of public buildings and its system of radial thoroughfares, make it perhaps the most beautiful of all cities.

In a brief reference to recent progress in city planning at home and abroad, sharp distinction should be drawn between the ambitious and often spectacular plans to create civic centres with striking architectural features, and the less sensational but often more important efforts to correct, where possible, the present plan, and to provide for future development a scheme which will permanently fix the arteries of traffic and allow as great a degree of flexibility as possible in the filling in of details. The establishment of civic centres, such as that now in process of execution in Cleveland, but which is confined to a limited area, and the more comprehensive plan under consideration by Chicago, which extends over many blocks surrounding the proposed centre, is certainly an admirable idea, and they will probably be worth while, whatever may be their cost. Their monumental dignity and beauty appeal strongly to the imagination and pride of the citizen, and the courageous optimism of the cities of the Middle West and the Pacific Coast may bring about their realization, although it will involve the destruction of costly improvements and the entire rearrangement of the street systems in their vicinity. Memphis and Kansas City, which once may have been considered somewhat featureless, not to say commonplace, cities, have been developing park and boulevard systems which have already made them notable, and they are doing it because it has been found to pay. Los Angeles, Portland and Seattle are working out plans for their future development along lines which would stagger the more conservative cities of the East.

Instances might be multiplied of cities which have awakened to the importance of correcting mistakes before it is too late, and providing for future extensions along more rational lines than those of the original plan, and of the striking increase in population, business and realty values resulting from this awakening. It would be impossible to do so within the compass of this paper, and the author will confine further comment upon progress in city planning to a brief review of what is doubtless the most conspicuous legislation along these lines which has yet been attempted, namely, the Town Planning Act adopted by the English Parliament in 1909. The material for this review was taken from the Act itself, from the various explanatory memoranda issued by the Local Government Board to the local authorities and to an analysis of the Act which appeared in the initial number of the *Town Planning Review*, published by the University of Liverpool.

The underlying idea of this Act, which applies not only to every great city but to every town in England, Scotland and Wales, is that every urban district has a powerful effect upon the territory outside of its corporate limits. The city plan is not and cannot be bounded by the red lines indicating the city or town limits. In the last analysis every part of a thickly settled country is either included within the limits of a municipal corporation or is so powerfully affected by its proximity thereto that the entire territory will inevitably be influenced by the operation of a Town Planning Act as general in its application as that of Great Britain. Heretofore no project materially affecting any city, whether that city be great or small, especially one involving the power to compulsorily acquire land, could be carried out without the express authority of Parliament. Almost the only Acts which were quite general in their application were those relating to sanitary housing, such as "The Housing of the Working Class Act" of 1890 and its several amendments. The most liberal enactment so far as the delegation of powers to local authorities is concerned was that of 1908 with respect to the Corporation of the City of Liverpool.

The General Act of 1909 applies to the whole of England and Wales, and, with slight modifications, to Scotland. Its object as defined in its opening section is the "securing proper sanitary condi-

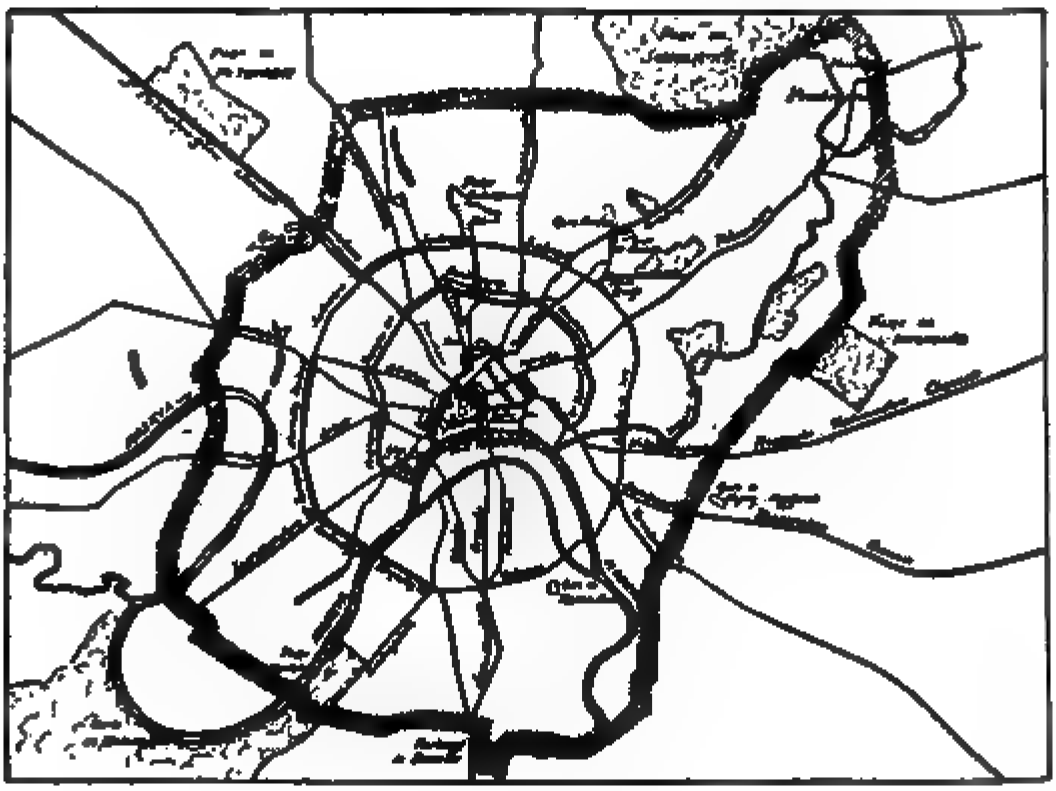


FIG. 1.—PLAN SHOWING TRAFFIC CIRCULATION OF MOSCOW.

The system of radial and circumferential streets in this plan is particularly noticeable, the latter doubtless following the lines of old fortificatons or city walls. Reproduced from "Town Planning," by H. Inigo Triggs.

FIG. 2.—PLAN SHOWING THE MAIN HIGHWAY SYSTEM OF THE BOROUGH OF THE BRONX, CITY OF NEW YORK.

Shaded areas indicate parks.

With a few unimportant exceptions, all of the streets indicated in this diagram are 100 ft. or more in width. The liberal park area (15% of the area of the Borough) and the system of connecting boulevards is conspicuously noticeable. These streets furnish an admirable system of main thoroughfares by which every part of the Borough can be readily reached.

tions, amenity and convenience in connexion with the laying out and use of the land and of any neighbouring lands."

Upon the Local Government Board has been conferred authority formerly exercised only by Parliament itself, the latter retaining, however, certain veto powers. The area which may be included in a scheme is any land which is in course of development or which is likely to be used for building or for open spaces, roads, streets, parks, pleasure grounds or incidental works, and may include land already built upon and even land not likely to be used for building purposes if it is so situated that it ought to be included in the scheme. The Local Government Board may authorize a local authority to prepare a town planning scheme if the Board is satisfied that there is a reasonable demand or call for such a plan. A scheme proposed and adopted by any local authority cannot become effective unless it shall first have been approved by the Local Government Board, which may refuse its approval except with such modifications and subject to such conditions as it may see fit to impose. Before approval by the Local Government Board notice shall be published by the London or Edinburgh *Gazette,* as the case may be, and if within twenty-one days of the time of publication no interested person or authority objects to the draft of the order of approval, it shall be laid before both Houses of Parliament for not less than thirty days during a session of Parliament, and if before the expiration of thirty days either House presents an address to the Crown against the draft or any part thereof, no further proceedings shall be taken, without prejudice, however, to the making of a new draft scheme. A town planning scheme once adopted may be varied or revoked by the same method of procedure as that followed in its original adoption. The Local Government Board is authorized to prescribe provisions for carrying out the general objects of town planning schemes, these objects being given in the widest terms in a schedule which is a part of the Act, including the laying out and improvement of streets and roads and the closing or diversion of existing highways, the erection of buildings and other structures, the provision of open spaces, both private and public, the preservation of objects of historical interest or natural beauty, sewerage, drainage and sewage disposal, lighting, water supply, the extinction of private rights-of-way or other ease-

ments, the disposal of land acquired by the local authorities, the removal, alteration or demolition of any work which would obstruct the carring out of the scheme, the making of agreements by the local authorities with owners, and by owners with each other, the right of the local authorities to accept any money or property for the furtherance of the object of any town planning scheme, and the regulation of the administration of such money or property, the limitation of time for the operation of the scheme, the co-operation of the local authorities with the owners of land included in the scheme, and the imposition upon land whose value is increased by the operation of a town planning scheme of the sum to be paid on account of their increase in value.

In addition to these general provisions there may be incorporated in any scheme special provisions defining the area and the responsible authority and especially dealing with local conditions, and these special provisions may vary or supersede not only the general provisions, but even Acts of Parliament, although when any general Act of Parliament is thus contravened, special opportunity is given either House by resolution to reject the scheme before it is finally approved.

A town planning scheme may originate in any one of three different ways:

1. Land owners may formulate a scheme which the Local Government Board may authorize, or after public inquiry may compel the local authorities to adopt.
2. Any representation may be made to the Local Government Board that a scheme ought to be prepared by a local authority, and the Board may, after public inquiry, order a scheme to be so prepared.
3. A local authority may prepare a scheme, but before any public money is expended a *prima facie* case must be made out and the sanction of the Local Government Board obtained.

The responsible authorities are given abundant power to enforce an adopted scheme by removing any building or work executed in contravention of the scheme and by carrying out at the expense of the person in default any work which is so delayed as to prejudice

PLATE 60.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
LEWIS ON
THE CITY PLAN AND WHAT
IT MEANS.

Fig. 1.—Vienna in the 19th Century, Showing the Inner Town and Fortifications.

Fig. 2.—Vienna, Showing the Ringstrasse and Inner Town.

Figs. 1 & 2 show the admirable use of the ground occupied by the fortifications of Vienna when they became unnecessary.

Upon it was located the superb Ringstrasse and a number of important public buildings, while a considerable area was left for private development.

Both of the above illustrations are reproduced from "Town Planning," by H. Inigo Triggs.

the plan, and the responsible authorities may be compelled by the Local Government Board to exercise these powers.

The expenses incurred by a local authority may fall under three different heads:

1. The cost of preparing and promoting a scheme.

The Act contains no provision as to this expense beyond the fact that it will be charged in the general tax of the district.

2. The cost of acquiring land for the purpose of carrying out a scheme.

Compulsory powers of purchase may be exercised by order of the Local Government Board without statutory confirmation, unless an impartial public inquiry shows that the land is unsuitable for the required purpose or cannot be acquired without undue detriment, in which case any order made by the Local Government Board must be confirmed by Parliament. The price to be paid for land compulsorily acquired is to be determined by a single Government Board arbitrator, and no additional allowance will be made by reason of the purchase being compulsory.

3. Compensation may be allowed the land owners for injury.

This compensation is to be determined by a single Local Government Board arbitrator, but no allowance is to be made for the limitation which an adopted scheme may impose as to the number, height, or character of the buildings which may be erected, nor for any requirement of a scheme which may be in force, nor for anything done after application has been made for the right to prepare a scheme. The principle of betterment is also recognized to the extent of one-half the increase in the value of property affected by the scheme.

It will be seen that the powers conferred upon the Local Government Board by the Town Planning Act are extraordinary and perhaps unprecedented, and it is quite probable that the success or the failure of the Act will depend to a large degree upon the manner in which the power is exercised.

The recent interest in questions relating to city planning can be largely credited to architects, landscape engineers, civic organizations, and those who, from motives which may be altruistic or selfish, wish to see their city made more livable and attractive. To these men and bodies must be given whatever credit is due for the move-

ments which have resulted in the establishment of dignified civic centres, the effective grouping of public buildings, and in many cases the cutting through of new thoroughfares. In few instances have engineers taken a conspicuous part in the planning or execution of the improvements other than the mere work of physical construction. If the principles enunciated in this paper are accepted as sound, it must be admitted that these spasmodic efforts, admirable as may have been their results in many cases, are not city planning. They are often spectacular and they attract the admiring attention of the public. Real city planning is more fundamental and will render unnecessary an enormous destruction of property before real constructive work can be begun.

City planning in the sense in which the author has used it is almost wholly constructive. Some demolition of improvements there must be, but it should take place before they have assumed great value, and before the sections in which they are located have assumed a fixed character. The work will not be done in the limelight, and the men who do it will not receive the credit and the applause which will be the portion of those who might later at great public inconvenience and expense correct mistakes which, but for their foresight, the original planners might have made.

While conferences and exhibitions of city planning are doubtless of great benefit in enabling one to see what is going on in other cities and in demonstrating the public interest in the subject, their greatest value consists, perhaps, in giving those responsible for the development of a city plan the opportunity of seeing the mistakes which other cities are striving to correct.

The creation of a city plan is no work for an expert temporarily retained for the purpose; it is no work for a commission specially created for the task and upon which there is an attempt to establish a balance between engineers, architects, civic workers, business men, etc. It is work which must be carried on patiently every day in the year. The services of experts should be secured, and their judgment might properly be controlling in some respects. This is no one-man task, but it is essentially the work of the engineer, or, rather, of the regular engineering staff, of the city. If the engineers are not alive to their opportunity; if they are not ready to profit by the experiences of other cities in all parts of the world; if they

undertake the problem as one of more or less precise surveying; if they are content to prepare a plan for undeveloped portions of the city along the conventional lines followed in the older portions, notwithstanding the palpable defects of the older plan—then they need not be surprised if the architects and the landscape engineers are subsequently called in to correct their mistakes, or if the idea becomes prevalent that an engineer is qualified only to build a city after it has been planned by someone else.

The author has no desire to detract from the credit which has been given to men like Carrère, Burnham, Brunner, Olmsted, Nolen and a number of others, for the admirable work done or proposed by them to redeem some of our cities from the commonplace. Their plans are, many of them, inspiring—some of them extravagant beyond hope of realization. Their genius can and should be availed of in the constructive work of making our cities beautiful, but the destructive features of their plans could be largely avoided if the engineers would bestow more careful study upon their task of preparing the original plan.

The general principles which should govern the creation of a city plan may be summed up under three headings:

Provision for the future growth.

Reasonable regard for the interest of the property owner and the taxpayer, as well as the public.

Economy, or an attempt to secure what is needed at a minimum of expense.

In making provision for future growth, some imagination is required. There appears to be a belief more or less general that imagination is something that the engineer should studiously avoid, but failure to exercise it is probably responsible for many of the defects in original city plans made by engineers. By imagination the author does not mean a capacity to dream and to produce results which he may think artistic, but the ability to estimate the future by the past, to grasp the probable and even possible growth and development of the city in population and commerce, to anticipate the various needs of a great number of people, to repress to a certain degree his own preconceived notions of the precise lines along which a plan should be evolved, and to take counsel with

others and not to limit such counsel to men of his own profession. No human being can foresee the precise lines along which a city will grow. Electric traction, the automobile and the telephone have made it possible to extend the radius of action of the average citizen to a degree which would scarcely have been credited a generation ago. The quiet suburb of the last decade has already become an important business centre of the city of to-day. While no one can anticipate such changes, it is a mistake to assume that the character of any particular district is permanently fixed. The problem is to devise a plan so flexible that with a minimum of expense for rearrangement it can adapt itself to changed and changing conditions. This is what is meant by the exercise of imagination tempered by common sense.

Regard for the interests of the property owner as well as the public implies a capacity to reach a desired result along the lines of least resistance, and to discuss frankly and freely with the owners of property the rational and most economical development for each section, insisting, however, upon the superiority of the public to the private interest. While directness and continuity are essential in main traffic thoroughfares, it must be remembered that by far the largest mileage of city streets are not traffic thoroughfares, but will be devoted to dwellings, and that their function is to provide light, air and access, with facilities for reaching as readily as possible the main traffic thoroughfares upon which will be located the shops and places of amusement, and which will be the routes to be followed in reaching more distant places of recreation, such as the public parks. To plan a series of residential streets with the same directness and continuity which should be given the traffic streets is not only unnecessary, but the result is unpleasantly monotonous and uninteresting, with no compensating advantage. There is no reason why individual preference and ideas should not be exercised by the private developer provided that his development does not interfere with the main arteries of traffic, and provided, also, that it is not inconsistent with good sanitary conditions. Some of the plans evolved for private development may cause a distinct shock to the engineer. This will do him no harm; in fact, he needs it occasionally for his own good.

Many developments made by individuals or corporations before

FIG. 1.—SKETCH SHOWING THE EFFECT OF PLACING A MONUMENTAL STRUCTURE ON AND OFF A GRADE SUMMIT.

FIG. 2.—PLAN SHOWING THE PROPOSED RECONSTRUCTION OF THE CENTRAL PORTION OF CHICAGO, IN ACCORDANCE WITH PLANS PREPARED BY MESSRS. BURNHAM & BENNETT.

The white lines indicate the proposed new thoroughfares.

The enormous expense of carrying out such a plan in a city like Chicago is quite apparent.

Reproduced from the report published by the Commercial Club of Chicago.

the completion of the plan for the district in which they are located could be incorporated in the final plan, provided there were a disposition on the part of the developers to confer and co-operate with the city authorities before making their improvements. Inasmuch as property sold as city lots depends for its value upon a street system which will afford access, it would not appear unreasonable to prohibit by statute the sale or offering for sale of lots in unmapped sections, unless the proposed plan of streets should first have been submitted to the municipal authorities for their examination, approval or correction in order that the proposed streets might be made to conform with the general plan of main highways proposed for the part of the city in which the property is located. A reasonable time, say three months, should be allowed for the acceptance, amendment or rejection of the plan submitted, and if the opportunity to do so were not availed of within that time, the owner might be absolved from any obligation to further delay the improvement and sale of his property. Such a requirement would not appear to be an unreasonable restriction upon the right of the owner to use his property to the best advantage, but would be a recognition of the right of the city to control in some degree the street plan upon which that property depends for its value, while the assurance to purchasers that the street plan is definitely fixed and that the homes they build will not be destroyed by a rearrangement of that plan, would add materially to the value of the property. It is quite probable that reputable real estate developers would not oppose legislation of this character.

Economic considerations are so dependent upon the laws under which the municipal engineer is obliged to work, and these laws are so constantly changing, that it is not only proper but necessary for him to assume that legislation manifestly desirable to accomplish good results with a minimum of expenditure will be enacted. The Legislature of the State of New York has initiated an amendment to the Constitution which will be submitted to the people at the next election, and which will permit the exercise by municipal corporations of the right of what is commonly known as excess condemnation, that is, in acquiring land for a public purpose, adjacent or contiguous property may be taken, or more property than is needed for the specific purpose. This power is not to be used for

speculation, but it will be of enormous value in enabling the City, both in the widening and extension of existing streets, and in the development of the outlying districts, to finance improvements which now appear impracticable on account of their expense. If acreage property could be secured even before the development of the street system, and of sufficiently large area to permit the laying out of a symmetrical park when the street system is finally determined, leaving the surplusage for sale, the financing of a system of parks in the undeveloped portions of the City would be a very simple matter. In disposing of the surplus property, sites for schools and other public buildings, commonly bought at enormous expense, could properly be reserved for future use, and it is not unlikely that both park and building sites could thus be made to pay for themselves. Such a plan is indicated by the diagram showing the subdivisions of an area included between main traffic thoroughfares. In the cutting through of new or the widening of existing streets in built-up sections of the City, the simple right to acquire entire parcels, portions of which are needed for the new or widened street, and the sale of the surplusage after the street shall have been constructed along the new lines, would on account of the enhanced value enable the City to recoup a large portion of the expense, instead of adding the entire cost to the permanent debt of the City and at the same time enriching abutting owners, first, through awards made for damage imposed, and then for the enormously increased value of the property which is left.

As already stated, there is no reason why subordinate residential streets should follow long, straight lines. This is in a measure true of main traffic thoroughfares, but in them the changes in direction should not be permitted to materially increase distance or impair directness. Topography and existing improvements may be such that expense may be saved by easy changes in direction, while at the same time the street will gain in interest and admirable sites will be afforded for important buildings, the lack of which sites is so painfully evident in the rectangular street plan of Manhattan.

The author's object in presenting this paper will have been misunderstood if it is considered simply one of criticism. An effort has been made to point out not only an opportunity which is presented

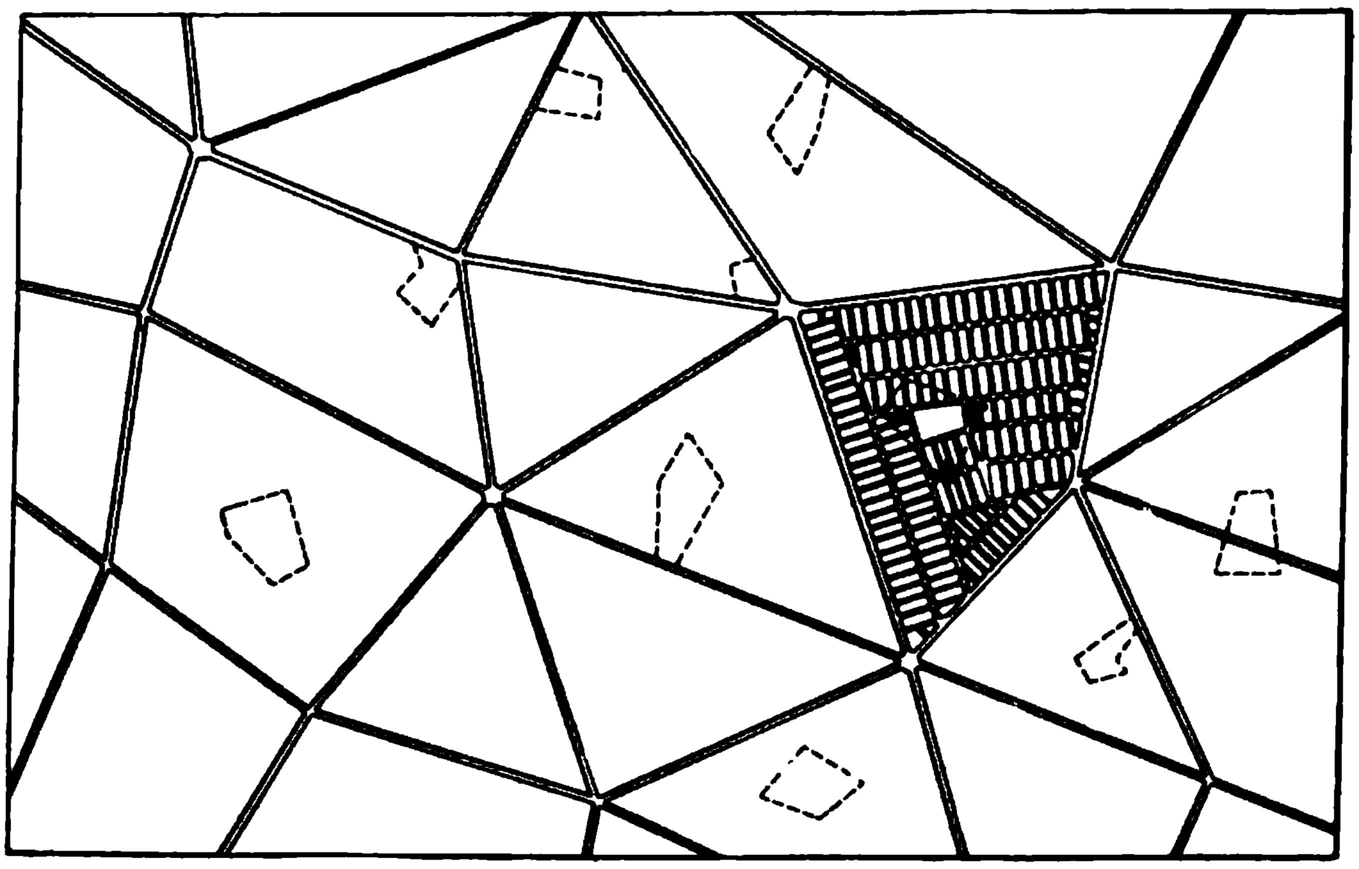


FIG. 1.—Sketch showing a system of main arteries as a basis for a city plan, and indicating the subdivision of one of the areas included within these arteries in such a manner as to interfere as little as possible with existing improvements. The main arteries are supposed to follow existing highways, with such straightening and widening as may be necessary.

The dotted areas indicate reservations for parks, building sites, or other public purposes, while in the area which is subdivided is shown the possibility of the sale of land not needed in order to pay for both park and building sites.

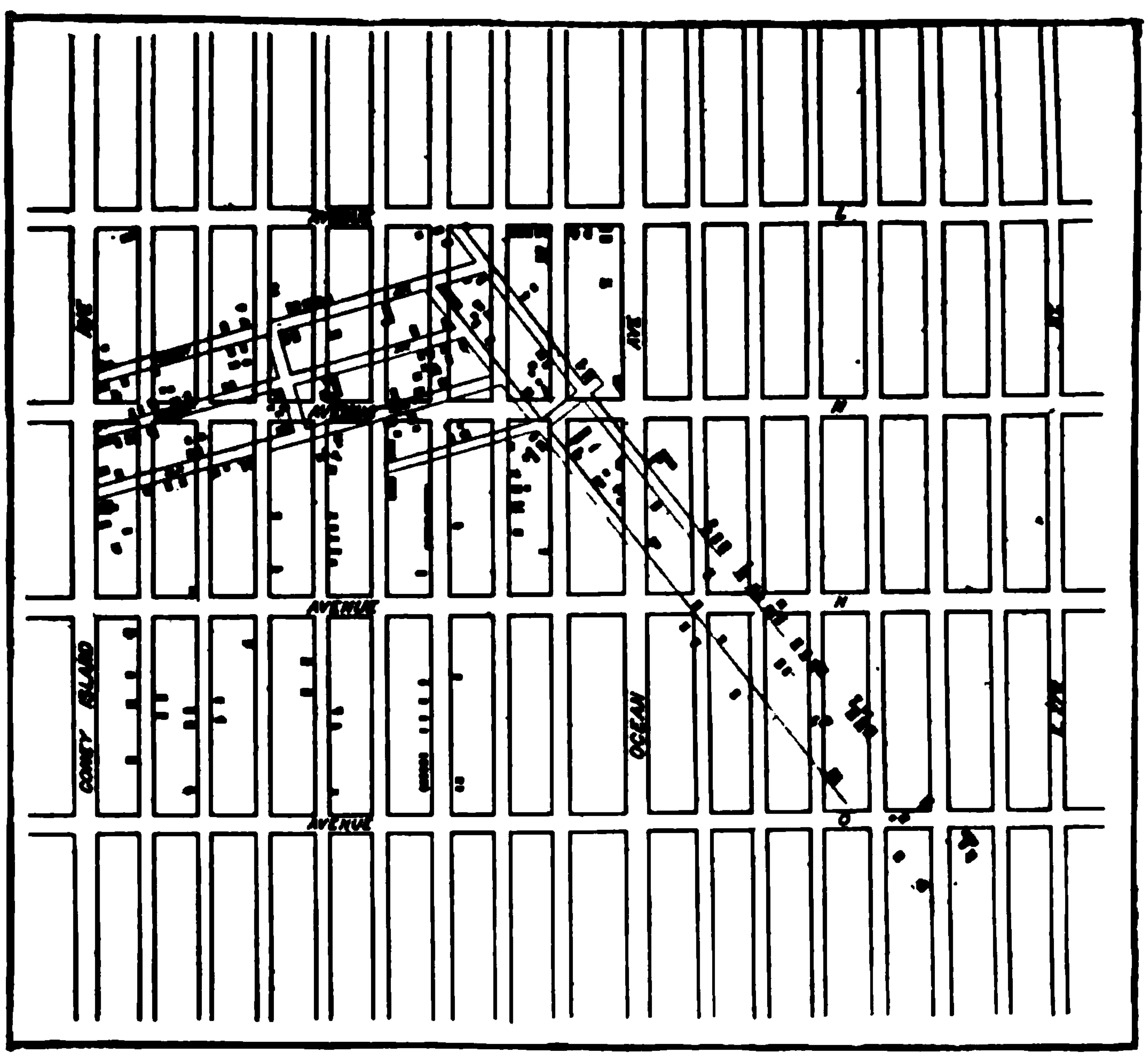


FIG. 2.—Plan showing disregard of existing streets and buildings in the creation of a rigid rectangular street system in the Borough of Brooklyn, City of New York.

The expense imposed upon the property owners by this policy is quite apparent.

to municipal engineers, but an obligation which is imposed upon them. There are others who would gladly assume the task of planning for the future development of our cities, and who would with special enthusiasm undertake their reconstruction. An attempt has been made to present some construction suggestions which should govern the preparation of the original plan in order that costly reconstruction may be rendered unnecessary.

DISCUSSION.

HENRY W. V[illegible], M. M. E. N. Y.—The attendance to-night shows how anxious we are to hear Mr. Lewis. He has sounded a keynote, I think, in his paper to-night and that is that in the development of a city we should make the most of what we have and not destroy as much as we can in re-building.

I will not take up your time in adding to what Mr. Lewis has said. We are especially favored to-night in having with us gentlemen whom we are not always able to hear, and one who has especially studied the plan of the City of New York. I am glad to introduce to you the Hon. Edward M. Bassett, who was, until recently, one of the Public Service Commissioners. I am sure we will be glad to hear from him.

EDWARD M. BASSETT.*—Mr. Lewis makes it plain, I think, that the street layout, and particularly the arterial street layout, is the fundamental basis of city planning; but what will you do with those cities that are already grown beyond the bounds of what any original planners could well foresee, whose street layout is inadequate and now must be altered in some way so that future growth shall be unhampered. We at once come to the necessity of diagonal and through streets in our modern cities, especially in cities like Chicago, New York, or St. Louis, that are on the gridiron or checker-board plan. Of course, Mr. Lewis, although he emphasizes the original street layout, does not intend that this other phase of city planning, city alteration, shall be overlooked. I know that no one appreciates it better than does Mr. Lewis. Through and diagonal streets in our great modern cities must be built through congested districts in order that the cities shall be prepared for future growth, because you cannot prepare the outside unless you also perfect the inside.

Walter L. Fisher, now Secretary of the Interior, gets right at the meat of this whole subject in his six page addendum to Mr. Burnham's magnificent "Plan of Chicago." Unless you attend to what Mr. Fisher says there, you cannot do what Mr. Burnham would do in Chicago. Mr. Fisher points out that Mr. Burnham's plan of new diagonal and through streets simply cannot be carried out, because of financial impossibility. The Constitution of the State of Illinois makes the plan too expensive. The reason of the excessive cost is because the constitutions of both Illinois and our State, and of all the States in the United States excepting three, provide that no private property can be taken except for a

* Attorney and Counsellor at Law, 277 Broadway, New York City.

public use and by giving just compensation. The Courts properly construe this strictly in favor of the private owner. That is, if you take land for a street, the ability of the city to take is limited by the street line, and therefore, where a corner is taken a disproportionately large price is paid. The increment that comes from the new street is reaped by the party that owns the rest of the plot and who, nine times out of ten, has collected from the city nearly all that the original building and plot were worth. Some of the provisions of our written constitutions, which were intended to be a protection to private property, are in our large municipalities turning out to be a means of oppression to the property owner. The constitutional amendment that Mr. Lewis speaks of would make it possible for the city to take whole plots and reap for itself those benefits and profits that come from a city enterprise such as the opening of a large diagonal street. This profit would largely pay for the new street. Take, for instance, the Flatbush Avenue Extension. There was an admirable opportunity for a new broad street to pay its own way, and if excess condemnation could have been practiced, it would very likely have done so, instead of being a burden of many millions upon the City. Moreover, it left plots and lot lines in chaos, to be built up with all ill-assorted buildings perhaps for a generation to come.

The city of Cologne places certain reasonable requirements as to the kind of buildings that can go up along its Ring-Strasse. Large handsome buildings can be erected with a certainty that blacksmith's shops, or one-story laundry buildings will not be built next door. Thus King's Way in London invites the best class of construction because the City of London makes leaseholds of the land abutting thereon conditional on the erection of suitable buildings. England and Continental countries have no written constitutions. Thus our constitutions are standing in the way of municipal development. The amendment referred to by Mr. Lewis will be voted on at the coming Fall election and all ought to vote for it and speak to their friends.

ARTHUR H. BLANCHARD.*—Mr. President and Gentlemen: As Mr. Lewis has admirably presented for your consideration the subject of city planning from all standpoints, it is only possible to enlarge on certain features in discussion of his paper.

The value of traffic censuses in planning for the future development of a city should be emphasized by engineers at every opportunity. The inherent value of statistics relative to traffic on city streets, state trunk lines and county main roads, obtained both previous to and after construction, is recognized by all en-

* Professor of Highway Engineering, Columbia University, New York City.

gineers who are familiar with the problems of modern highway engineering and who take into careful consideration the economics of the construction and maintenance of highways and the development of avenues of transportation and intercommunication.

To determine how it will be possible to save the State, county or municipality thousands of dollars by acquiring property adjacent to present rights of way in order to provide for an increase in the widths of highways required in the comparatively near future, is a problem worthy of the careful attention of engineers. Unfortunately only a few highway departments of our States and municipalities have given this subject the consideration which it deserves. Many believe that the expense involved is not justified, but it should be borne in mind that, with the data at hand acquired by a systematic traffic census of the main arteries of a city or State, the problem of determining the requirements of the future is greatly simplified. Deductions relative to development must, of course, be based upon the experience of other cities and communities and hence the growth of our large municipalities is worthy of careful study in this connection.

Much material is available at present relative to the development of traffic in European cities. Those interested in this subject will find the reports on traffic by the London Traffic Branch of the Board of Trade full of valuable suggestions. Paris has been referred to by Mr. Lewis as an example to be followed with respect to many details of city planning. Allow me to cite one instance of what the City of Paris must do in the near future, if it is to have the same reputation as a city beautiful one hundred years from now that it has had since the days when Baron Haussmann assumed the direction of the city plan. Due to continual congestion of traffic the municipal engineers of Paris are recommending to the Ministry of Public Works the tearing down of the costly buildings along the Rue du Rivoli, one of the main arteries leading to the Place de la Concorde and from thence to the Bois de Boulogne, in order to provide adequate width of roadway for this important thoroughfare. The above recommendation is one of many made by the Parisian engineers, which the Ministry of Public Works will, without doubt, adopt within the next five years.

Crowded streets are neither beautiful nor commercially economical, and it is hoped that the American public will soon recognize the wisdom of the widespread movement throughout Europe in favor of the systematic planning for the development of municipalities.

Henry W. Vogel, M. M. E. N. Y.—We would be pleased to hear from some gentleman representing city planning in the Borough of Richmond, the borough which President Cromwell has frequently demonstrated to us as the greatest borough in Greater New York.

GEORGE W. TUTTLE, M. M. E. N. Y.—I would like to say that I was greatly interested in our Past President's paper. It is an admirable summary of important principles which should govern street planning, and the paper will be very useful to all engaged in this line of work.

Remembering that streets are among the most permanent things we have, and that they will doubtless remain for many generations to witness to our foresight or folly, the greatest care should be exercised in laying them out right.

ROBERT R. CROWELL, M. M. E. N. Y.—I was very much interested in Mr. Lewis's paper, as I am much interested in "City Planning." I would like to ask Mr. Lewis whether the Local Government Board ever tried to work out a plan for any of the towns in England under the law cited, and whether they have ever completed any plan under that Act? Does Mr. Lewis think, under our government at the present time, the City authorities would be given such broad power?

The authorities in the Borough of Queens transmitted to the Board of Estimate and Apportionment, for its approval, many plans on which wide highways or streets of 80 ft. and 100 ft. had been depicted. We have had a great amount of opposition to all of them. Under these circumstances, the head of a department is hardly justified in getting up plans which are supposed to be sufficient to take care of the future traffic in the Borough of Queens, only to have them turned down on account of the cost, although it is conceded that they will be necessary in the future.

Mr. Lewis spoke about the beautiful piece of property which is now being laid out at Forest Hills, which was supposed to be a project advanced by a philanthropic society, for the benefit of the working-man, but has developed into an ordinary land company. There is no doubt that while the company has erected very pretty buildings, and made attractive improvements, it has also laid out streets 32 and 40 ft. in width, and in some cases offsets of 15 ft. in a block. In one case, at intersecting streets, the street is 40 ft. in width, and after proceeding about 100 ft. it is enlarged to over 100 ft. in width.

Continental Avenue is laid out 80 ft. wide, and Greenway Terrace 70 ft. wide. On these two streets the company is erecting large four-story buildings, which above the first floor are extended out over the sidewalk to the curbs, thereby reducing the distance between buildings about 35 ft. and bringing the large high buildings within 40 ft. of each other. In the case of the rows of small buildings, they are about 75 ft. apart.

The company has requested the Board of Estimate and Apportionment to adopt their map as a portion of the final map of the

City. If the City authorities do approve the plan, when the streets are legally opened or ceded to the City, the company will have to demolish the large buildings which they have just erected, as a large part of the buildings are upon the streets.

Just imagine 32- and 40-ft. streets practically (geographically) in the center of the City of New York, where they are spending millions of dollars for improved sanitary conditions—light, air, and the elimination of "tuberculosis"—and this, by a philanthropic concern.

The Board of Estimate and Apportionment has not authorized the legal opening of a street in the Borough of Queens 100 ft. in width since "Consolidation," with the exception of the diagonal street leading from the Queens Borough Bridge to Thomson Avenue, Ditmars Avenue in the Second Ward, the Rockaway Road in the Fourth Ward, and Second Avenue in the First Ward. Second Avenue was laid out in 1873, and partly improved along those lines.

A number of streets in the borough have been laid out 80.01 ft. in width, and these are designed on account of their location to be the arteries of the borough; but because it cannot be shown that these wide streets are necessary at the present time, the plan is opposed by large numbers of the people, with the argument that if the future traffic demands wide streets, the future generations should supply and pay for them, although every lot on the street may contain a building, and the destruction would be enormous, in fact, prohibiting the widening, while at the present time very little or no improvements exist upon the proposed streets.

One of the principal streets within our borough is Myrtle Avenue, extending from the Borough Hall in Brooklyn to Richmond Hill, or 4½ miles in length; it is at present 70 ft. wide. It lies between cemeteries and public parks, through which no other parallel streets can be laid out or constructed within one mile on the south and ¾ mile on the north. It was proposed to widen this street to 100 ft., but the people who might be assessed for the widening made such a strenuous objection that a Select Committee of the Board of Estimate and Apportionment concluded to have the plan modified by reducing it to 70 ft. It is obvious that within a few years the City authorities will be severely criticized for not widening the street when it could be done at the present time at a comparatively small cost.

Mr. Bassett spoke of the advantage of diagonal streets in a rectangular system. There is no doubt of its advantages, but it is a hard matter to get a rectangular system with streets of sufficient widths for the future requirements of traffic. The property-owners will not approve, and will strenuously object to laying out streets, except of a minimum width, and they will consider it

a loss of property to have a diagonal street which necessitates the laying out of gore lots. They take the ground that small and few streets answer their present purposes, and if the future traffic requires wider streets, then the future generations should provide them.

Mr. Lewis draws attention to the fact that "City Planning" is really the work of the engineer, and that he should draw upon his imagination. In other words, he should digest the possibilities, and anticipate the probabilities, but right here is where the Department engineer fails, not because his imagination is wrong, but because he has no control over the enforcement of his plans, and the refusal of the general public to accept plans laid down for the future growth of the City, because it costs a little more to take care of the future than it does the present, although the destruction of the future will amount to many hundred times the cost of the present.

It must be recognized that public officials are human, and that many of them are elected by the votes of the people, and when the question comes down between the future necessity of the City and the engineer on the one side, and the local tax-payers, who are likely to be considered as opposed to the improvement, on the other, it is obvious what will be done with the plans.

Some of the City's finest plans have been disapproved through the intervention of the citizens' objections; but in such cases the engineer should be ready to save as much of the plans as possible. instead of losing heart and interest until too late to save any of it.

HENRY W. VOGEL, M. M. E. N. Y—We have Commissioner Ford with us. Mr. Ford is deeply interested in city plans, he having studied the whole three hundred miles of waterfront of the City of New York.

WILLIAM G. FORD, M. M. E. N. Y.—Mr. President, your calling upon me is an unexpected pleasure, as a young lady said to the young man upon a certain auspicious occasion. When I came I had only expected to listen to what I knew would be a splendid paper by Mr. Lewis, and had intended to profit by it, without discussing it. Though living in Brooklyn, I no longer represent it at all officially, since my office of Jamaica Bay Improvement Commissioner ceased upon the date of filing the final report last year.

I feel that Mr. Lewis has been an educator, and I feel it is rather cheeky in a student to criticize the professor, but I can properly endorse some of the ideas of the professor, since with many of them I am in accord. I have never visited Vienna, I am sorry to say. It is one of the cities that I have in my list for "next time," but I have visited some of those that Mr. Lewis has portrayed to-night, including Paris, Berlin and Moscow, cities which

are conspicuous, perhaps, in the wonderful development of the circumferential boulevards, with their radial connections, due in most cases to the opportunities afforded by the destruction of the old fortifications, which became a blessing in disguise in that respect. I never quite reached Dalny; I have been close to it; but the three distinctly planned centers of the European section, the railway, commercial and residential, all with their circumscribed boulevards and their radial streets, were truly in accord with the old-time systems in Europe, and this new city having been planned and developed by the Russians, was the natural outcome of the Moscow influence. It is a modern city in which these old traditions, developed through the abandonment of obsolete fortifications, have been brought forward to usefulness. As Mr. Lewis brought out the plans of Paris, Berlin, Vienna, Moscow and Dalny, I could not help thinking of an interesting situation we have in one of the present undeveloped sections of the Borough of Brooklyn and part of Queens, a thing, by the way, I know Mr. Lewis has very close to heart. In the construction of the conduit system for Brooklyn's water supply the City acquired a long belt of land, and holds it to-day. It is of little utility except as a resting place for the conduits. It would lend itself readily to a treatment for boulevard and parks combined, just as the sites for the old forts, eventually of little utility, lent themselves to circumferential boulevard systems in Europe. Moreover, the sites of the conduit lands would make a good dividing line between the street systems developing from the north southward, and those to be developed from the south northward.

Consider the waterfront of Jamaica Bay, for instance. This should be developed on street plans made primarily for waterfront improvements. They could be brought back to this boulevard and made to co-ordinate through it as a dividing line with the interior street system, and, at the same time, utilize at almost no expense for acquisition, a property of very considerable width, for traffic and breathing spaces, etc.

I made a few notes as Mr. Lewis went along and what I could gather from the other speakers, and it seems to me that what he said about flexibility is something that we can take into serious consideration with profit, not only in connection with city planning, but in connection with every engineering feature about New York. We have had so many conspicuous examples of under-planning, that it seems to me that it is safer now for the engineer to over-plan than to under-plan. I do not mean to say that he should do that to an unreasonable degree, but his own mind should magnify and then cut down to the necessities of the case through the probable limits in appropriation and the approval of his plans.

In connection with the planning of arterial roadways, for instance, I think that we may do that very properly if we do not exceed reasonable limits, and I think we may meet such objections as Mr. Crowell brought forward in his remarks about planning 100-ft. streets by judicious temporary restrictions.

Undoubtedly there are districts that are not prepared now for 100-ft. streets, where they will be welcomed at some time in the comparatively near future. Although they were planned now as 100-ft. streets and the objection were made that the improvement will be too costly and the assessment on adjoining owners prohibitory, as was the case in one of the English districts Mr. Lewis referred to, the objection can be overcome. For instance, where the intended *ultimate* width of *roadway* is unwarrantable at the present time, and the attendant assessment of adjoining property unjustifiable, under proper restrictions and authority the *roadway* might be *constructed* in the beginning of lesser width than finally intended. In other words, we could place a roadway of lesser width along the axis of the street and let the space between the sidewalks and the roadway go into grass plots; or we could make two roadways of small width and place a park in between,—either ornamented or simply as grass plot, so that in the future that road could be made full width, without having to widen the street officially and condemn costly property.

The idea of having our blocks 200 ft. wide throughout all of Manhattan, for instance, or 200.37 ft., seems to preclude certain development opportunities. For instance, there would be no opportunity in our development in New York to lay out a plan like that of St. Peter's Cathedral in Rome. There should be some flexibility in that way, so that we could have a variety from the gridiron system, and avoid what has occurred in the Library building Mr. Lewis has referred to, the only places from which you can see it being such as the northeast corner of Forty-second Street and Fifth Avenue.

It seems too bad that such a creditable thing should be lost from sight. We have good examples in Paris of effective placing of public buildings. If we had had more intersections in New York City where at least three streets come together, and particularly where we could locate those on the high points, and still better, if we could locate them along lines where the grades would be concave instead of convex, it would have been a great advantage. Compare the location of Arc de Triomphe in Paris with that of our arch in Brooklyn.

It would be an advantage to the city and in city planning, if we would arrange, as far as possible, to leave open spaces at intervals, particularly at high points and low points, keeping in mind the

characteristics of the purposes for which they are intended and the effect they will have upon realty values.

It has been my agreeable duty to make plans for some three square miles of a section on Long Island, reachable from the Pennsylvania Depot, Manhattan, in forty to fifty minutes, which, strangely enough, bears almost exactly the same name as the English development referred to by Mr. Lewis (Hampstead Garden), that of "Hempstead Plains," and which is to be a somewhat similar development.

While it is the intention of the Board of Directors to keep at least half of it out of the market for five years, the Board has, with unusual foresight, had the plans include the street system, drainage, sewerage, sewage purification and disposal problems for the whole tract, so that as the development finally spreads it will be a harmonious one.

AMOS L. SCHAEFFER, M. M. E. N. Y.—Mr. President and Members of the Society: Judging by the splendid tribute which Mr. Lewis has paid to the system of wide streets in the Borough of the Bronx, it does not seem necessary to come to the defense of the planning of that borough. The excellent system of 100-ft. streets which he has shown us demonstrates that the development of the street system in the Bronx is on broader lines than that in any other borough in the City.

There is a considerable development of property on the part of private enterprises in the outlying sections of some of the boroughs over which the City has very little or no control. These private development companies frequently lay out systems of streets on their own property whose widths are less and whose grades are steeper than the City's standards. In cases where the City has already mapped the territory, but has not acquired title to the streets, these companies frequently disregard the existing street system and lay out new streets according to their own ideas.

Streets are graded according to plans which are far below the standards used by the City. The City specifications provide that in rock cuts the excavation shall be made a certain depth below the finished grade in order that no rock excavation will be necessary before putting down a concrete foundation for a pavement. The City specifications also do not permit stones above a certain size to be used in embankment in order that trenches for sewer and other connections may be dug with greater ease. These companies frequently build streets in embankment by using for fill the rock which is taken out of an adjacent rock cut to within a few feet or even a few inches of the surface of the finished street. This rock fill varies in size from stone dust to stones as large as can be handled. Excavation in a trench through this kind of material is

as difficult, if not more so, as through ledge rock. The curbing, sidewalks and other appurtenances are also inferior to those prescribed by the City. Sewers are built of smaller sizes and at lesser depths than are permitted under the City specifications.

The pavements frequently are also inferior to those prescribed by the City. I have in mind a concrete pavement which was laid in the Bronx in 1909 and which is now in so bad a condition that the maintenance charge is greater than the interest on a new pavement would be. This pavement was put down by a development company which now expects the City to repave the street out of the repaving fund, although it was originally paved without a permit and without the knowledge of the borough authorities and was never accepted by them, and yet the City would be liable for any accident which might happen on account of its bad condition.

Where the ground is rolling, street lines and grades are sometimes established on a plateau without regard to the influence which these lines and grades may have on adjacent property, which may not be so fortunately situated. In other words, good street lines and grades may be fixed on high ground which is comparatively level, but to which it may be impossible to connect streets on adjacent property on account of the heavy grades which are necessary to meet those already established on the higher ground. These conditions arise when the high ground is developed by private interests and the adjacent low ground is developed by the City or by other private interests. The improvements made by these private development companies frequently present a much better appearance than the more permanent improvements made by the City. I am happy to state, on the other hand, that there are some development companies which are very careful to comply with the standards established by the City. They are the companies which develop one tract after another, and they realize that good work is an asset.

The City needs better control of the planning done by these private enterprises than it exercises at present. It is a question if Section 1540 of the Charter could not be applied in these cases. It provides that no map of the subdivision of property shall hereafter be registered or become effectual and binding as a dedication of the streets until such map has been submitted to and approved by the Board of Estimate. The owners of property would probably take the position that they did not want to dedicate the streets and therefore they were not required to submit maps for approval. This is only partly true. Properties are developed for the purpose of selling lots, after which the original owners retire from the control of the streets and the City is compelled to assume it. Title to streets on private tracts of land eventually vests in the City without any

formal dedication, because the City must exercise certain police control from the time they are thrown open to traffic, which, in the opinion of the Corporation Counsel, constitutes an acceptance of title. None of the development companies intends to maintain perpetually the system of streets which they develop; they well know that the City is compelled to assume all responsibility for them. It would seem, therefore, that when property is privately developed, title to the streets will at some time vest in the City. It is not quite clear, therefore, why the City should not insist on applying the provisions of the Charter and require the approval by the Board of Estimate of all maps showing the laying out of streets.

Mr. Lewis has only referred to the width of streets in a general way except that he advocates a system of wide thoroughfares. The plan of the Bronx which he has shown us indicates that it is fairly well provided with streets of a width of 100 ft. and over, and that they are well distributed throughout the borough. City planners advocate streets as narrow as 40 ft. I am of the opinion that streets of this width are entirely inadequate for the kind of development which may be expected in New York City, and that 60 ft. should be the minimum width permitted. A 40-ft. street may do very well for cities where cheap private houses are provided for the poorer classes. This type of houses, two stories in height, is very common in Philadelphia and some other cities. New York, however, is building up with apartment houses which require wider streets to provide sufficient light and air. Ten years ago, the two-family house was the general type of construction in the Bronx. To-day five- and six-story apartment houses of a good grade are built in what might almost be called the outlying sections of the borough. This, and a better type of building has been the rule in Manhattan for a long time, and will undoubtedly become so in all the boroughs.

Engineers are more or less criticized for the so-called extravagant street systems which they provide. The Bronx, which has an abundance of wide streets, has but few good cross-town thoroughfares, and some of those which it has were not planned originally as such, but connections and extensions were made to existing streets. The reason for this probably is twofold. First, in the early development of the borough, all traffic was to and from Manhattan, and second, the high ridges extending north and south, west of the Bronx River, formed a natural obstacle. The time is not far off when additional cross-town streets must be provided and the existing streets must be widened. This is not offered as a criticism of the planning of the street system of the Bronx, but to show that the City planning is rarely, if ever, done on too large a scale, but nearly always on too small a scale. I think the Bronx should be

congratulated on the broad lines on which its street and park systems were laid out.

ARTHUR S. TUTTLE, M. M. E. N. Y.—The original treatment of waterfront streets in the Borough of Manhattan is perhaps one of the best examples of failure to consider what to-day would be one of the first essentials of a suitable plan. Here we have a street occupying a position immediately adjoining the bulkhead line, with no intervening area available for either manufacturing interests or for inland transportation lines, with the result of seriously crippling commerce, and at the same time depriving this section of what might have been an enormous advantage for home enterprises. This difficulty has, to some extent, been removed through special laws under which the City, through its Dock Department, may divert from public use portions of marginal streets and erect buildings thereon, an advantage which has been largely availed of. Had the original plan been prepared along lines now followed in new territory, it is safe to say that properties in the congested waterfront section of Manhattan would now be given over to manufacturing use instead of being devoted to varied and small business interests, among which the saloon is not the least prominent. It is also probable that the Eleventh Avenue track removal problem would either never have existed, or that its solution would have become comparatively simple.

That New York has held its own as the principal port of our country is evidently due more to its strategic position than to an intelligent shaping of the City plan to accommodate what has always been its chief asset.

An examination of the older portions of the City map as prepared for other sections, also shows what now appears to be an inexcusable indifference to what are to-day considered as essentials in city planning. We find street systems laid down along lines entirely inconsistent with those of roads which had long before been recognized as public highways, and notwithstanding that a reconciliation of old and new was quite feasible at the time when the plan was originally prepared, that railroads have been given no recognition in determining street lines and grades at the point where they adjoin or intersect, and that plans depending largely for their practicability upon the taking of cemetery or jockey club property have been given recognition to such extent as to make their recall impracticable, and this notwithstanding that such corporations have protected themselves under special laws which prevent the municipality from taking any of their lands from them.

The inability of the City to readjust property holdings as required to discontinue old streets and substitute new ones, almost invariably forces a mutilation of the plan by adding the former to

it, while the mutual ignoring by the City and by railroad corporations of the other's interests has involved a needlessly large expense for the removal of grade crossings, beside frequently resulting in both decreasing the usefulness which was originally intended for the street system and the facilities of the railroad for properly handling its traffic.

I am not prepared to admit that these criticisms of the work of the past can properly be wholly charged to the engineer, for, then as now, other interests and other municipal officers have exercised more or less responsibility in fixing upon the plan which is to govern the city growth, but it is safe to say that never before has the engineer been placed in such a strong guiding position, and that his prominence in the city planning work of the future will depend upon the degree in which he recognizes the various forces and intricate problems which must be given due consideration in the preparation of a proper plan, and the limitations placed upon a municipality, both by legislation and financial considerations, which might serve as insuperable obstacles to prevent its carrying out.

It seems to me that this paper is a timely one, and that the author has pointed out the ideals which should govern the city planner in his work.

Henry W. Vogel, M. M. E. N. Y.—Mention was made in the paper this evening of not confining the work to the corporate limits of the City, but taking cognizance of the surrounding territory. The City of New York did this many years ago. In 1869 surveys were commenced of that portion of The Bronx, which was then a portion of Westchester County, which lies west of the Bronx River. Surveys were made in accordance with specifications, and maps prepared to an 80-ft. scale showing buildings, roads, elevations and other topographical features. Such maps formed the basis of a comprehensive study of street and sewerage plans.

Nelson P. Lewis, M. M. E. N. Y.—In the discussion of this paper Mr. Bassett has noted the necessity for new and especially for diagonal streets in cities which have already been built up. Inasmuch as the paper was designed to emphasize the fundamental considerations which should control the preparation of a city plan, little space was given to the question of correcting defects, except to point out the desirability of avoiding the necessity of such corrections wherever possible. The cutting through of new diagonals is often essential, and when done a makeshift policy should not be followed. It is occasionally necessary to use the knife and to cut deeply into the existing plan.

Mr. Crowell has asked whether or not the British Local Government Board has ever worked out a plan under the provisions of the Town Planning Act. When it is remembered that the Town

Planning Act was passed by Parliament near the end of the year 1909, and in view of the machinery provided for the initiation, the elaboration and the final approval of a plan as outlined in the paper, it would not be surprising if none of the projects has been finally consummated. Since the presentation of the paper, however, the author has learned of at least two plans which have been finally adopted. When it is realized that during a corresponding interval few, if any, street opening proceedings have been initiated and completed under the laws governing the City of New York, the small number of street planning projects which have been consummated is not surprising. Mr. Crowell criticizes the plan of the Sage Foundation Homes Company at Forest Hills, and notes that certain streets have been laid out at a width of 32 and 40 ft., while offsets of 15 ft. are shown in certain street lines, while he also notes that on the narrower streets the buildings will be placed about 75 ft. apart. While the plan of the company is one which the City cannot consistently adopt in all of its details, there is no reason why the lines adopted by the City for the streets of extremely small width on the company's plan should not provide adequate street widths which will include the narrower streets which have been laid out, together with some of the area which it is designed to use for planting and other decorative treatment. This would carry out the idea suggested by Mr. Ford of restricting the paved roadway and reducing the cost of its improvement until such time as a greater roadway capacity becomes necessary. The object lesson in the landscape treatment of the streets at Forest Hills will be a valuable one, and it would in the author's opinion be unfortunate if it were not carried out substantially along the lines indicated by the company's plans.

The opposition to the provision of certain wide streets in the Borough of Queens is certainly discouraging, and Mr. Crowell expresses the belief that in view of the opposition of property owners to adequate streets in a rectangular plan, it would be impossible to win their approval of plans providing diagonal streets of generous capacity. He appears to have in mind diagonal streets superimposed upon a rectangular plan. The author, however, believes that the so-called diagonal streets or the direct lines of traffic by which each part of the City can be readily reached from any other part should precede the establishment of any rectangular system, which latter should be entirely subordinated to the main arteries of traffic. The detail plotting between these main thoroughfares should be an incident and not a controlling feature of the general plan.

Mr. Schaeffer suggests that all plans for private development should be first approved by the Board of Estimate and Apportion-

ment. The author doubts whether under our present laws any restriction can be placed upon the use which a property owner can make of his own land or the kind of street system he can adopt, so long as the public is ready to buy the lots he offers and take their chances that they will front upon City streets. It was suggested in the paper that legislation might be secured which would prohibit the offering for sale of lots in unmapped sections until the municipal authorities were given an opportunity to approve, modify or reject the proposed street layout, and the opinion was expressed that reputable real estate developers would not oppose such legislation. This is probably the extent of control which could be exercised by the City authorities.

Mr. Schaeffer also notes that City planners often advocate streets 40 ft. in width, while he expresses the belief that 60 ft. should be the minimum width permitted. In some cities where the two-story house has become a habit, streets 40 ft. wide, with shallow lots, may be proper, but in the City of New York it is impossible to foresee how soon small single family houses will give way to the tenement, especially in the neighborhood of Rapid Transit lines. In this City at least, it would seem that the objection of Mr. Schaeffer to the 40-ft. street is well founded, although, as already noted, there is no reason why the improved roadway should not be constructed at a reduced width until such time as the traffic requires greater capacity.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 67.
PRESENTED OCTOBER 25TH, 1911.

THE CONTRACTOR'S VIEW OF CITY CONTRACTS AND SPECIFICATIONS.

BY C. A. CRANE,* M. M. E. N. Y.

WITH DISCUSSION BY
HENRY W. VOGEL, GEORGE W. TILLSON, JOHN C. WAIT, EMIL DIEBITSCH, MERRITT H. SMITH, HENRY L. OESTREICH, WILLIAM W. BRUSH, MAX BLATT, THOMAS H. WIGGIN.

Any views which may be advanced in this paper can hardly claim merit as possessing novelty. In the first place, I am not, strictly speaking, a contractor, but my connection with the General Contractors Association has enabled me to learn pretty accurately what contractors think about city contracts. The subject is one which has been often and thoroughly discussed for the last several years. A most admirable paper, with many of the points which such a discussion as this must entail, was presented before your society by Mr. John C. Wait, formerly an Assistant Corporation Counsel, some six years ago. The matter was also very exhaustively discussed before the American Society of Civil Engineers in a paper presented by Mr. William B. Bamford, in 1910, and "The Contractors' Point of View on Engineers' Contracts and Specifications" was the subject of a paper before the Association of Engineering Societies, presented in July, 1907, by Mr. James W. Rollins, Jr., president of the contracting firm of Holbrook, Cabot & Rollins.

* Secretary. The General Contractors Association.

However, in spite of the discussion brought out by those papers, and the almost unanimous agreement that contracts were too one-sided, no perceptible change for the better has occurred. The reason, perhaps, is, because the parties most interested have not addressed their appeals to and concentrated their efforts upon a body authorized to act.

Every one of you engineers here to-night will agree with me that there are many unfair clauses in contracts upon which you have been engaged, but individually, you may say, "I didn't prepare it—I had nothing to do with the specifications—why don't you make the kick to the man who drew it up?" When we find the man who drew it up, he says, "These contract matters are up to the Corporation Counsel," or "They are regulated by charter or ordinance." As to the specifications, unless they be for some extra large undertaking, the old ones are copied year after year because there has been no general demand to change them.

What is the use, then, of presenting this paper? What good will it accomplish? The very fact that you seek the discussion leads us to believe that your minds are open, and there is always the chance that a seed or two will light on fertile ground, and that some day, if anyone present should be on a committee to revise specifications, he might give some heed to suggestions advanced in this way.

I know that engineers are not perpetually biased. They may be so as long as they remain in the city service, but their views undergo the most astounding changes when they enter the employ of a contractor, so much so, that often the contractor's view is merely the reflection of that of his engineer.

Now we are all agreed on *one* thing. None of us will ever live to see a perfect contract on city or any other public work, at least not universally regarded as perfect, and this is due to the conditions which govern the letting of public work. So long as the bidding on contracts is unrestricted, the contract must of necessity be drawn to protect the city, or the state or the government, as the case may be, from dishonest practices, and not only the dishonesty of contractors, but public officials—yes, and engineers as well. No reputable contractor can object to this condition, or will he deny its necessity, but what he does object to is that those clauses which

are inserted in the contract more for protection than literal enforcement, are often applied to him regardless of good and substantial performance, in order to secure strict compliance with the specifications. I allude to the so-called "Club Clauses." I believe the statement made by Mr. Rollins, in his paper just alluded to, is no exaggeration, that, "if an engineer demands in full that every and all conditions of the specifications be carried out, the job is a failure financially." Every contractor realizes that his success or failure on a piece of work depends in a large measure upon the personality of the engineer having it under direct charge, and this assertion is no reflection upon the integrity of the engineer, but upon his ability to know good work when he sees it. And believe me, the man who insists on hair-splitting exactitude is easier to fool than the practical and real engineer who gages by results. Mr. Rollins is an engineer, as well as a contractor, and has had an opportunity to study the question from both sides. He says: "Every unnecessary or unfair clause in a specification has its part in limiting competition and in lowering the standard of honesty among contractors. A clause that may be used as a club can be avoided in one of two ways, either by not bidding on work governed by the clause or by using graft to ensure that it shall be a dead letter." An instance of one of these impossible requirements, or club clauses, is to be found in the contract for asphalt pavement in the provision for tests just prior to the expiration of the guarantee. The clause provides that if any portion of the pavement shall show a variation of more than $\frac{3}{8}$ of an inch under a 4-ft. straight edge, such portion shall be immediately repaved by the contractor. Is there a pavement in the country, let alone Greater New York, which can comply with so rigid a test after five years' usage? I very much doubt it, and at the same time I have never heard of any engineer who applies his four-foot rule to the entire surface of the street before issuing his certificate. Perhaps this clause was responsible for the report of an engineer in the Bureau of Highways not long ago who refused to certify that the work had been placed in acceptable condition because the pavement still showed waves *of sufficient magnitude to make water hesitate!* In making the statement that this impossible test is not resorted to, it should not be presumed that it has been avoided by payment of graft, as might be assumed

from the foregoing quotation. It is simply because the requirement is so thoroughly ridiculous that it is hard to conceive of any engineer who would have the nerve to proceed towards its enforcement, or of any Borough President or Court which would sustain him if he should. You may argue, then, that if no attention is paid to it, the clause is harmless, and why worry about it! The same reasoning applies to the loaded gun in the bureau drawer; it is harmless as long as it is left alone, but sooner or later someone is liable to come along and get hurt because he didn't know it was loaded.

But this paper is not intended for generalities. You want to get down to cases and find out what contractors think of the contracts which you and they are dealing with to-day, right in this City. Many of the objectionable clauses are found in nearly every contract, so that the views on one will fit all.

Take first the contracts prepared by the Board of Water Supply for the Catskill Aqueduct. They are conceded by contractors to be as fair as any they have ever worked under. The specifications are explicit in defining every detail that enters into the construction, and just what the payment for each item includes. No expense has been spared in procuring the best engineering skill, and the advance information to bidders is presented in a most complete manner, yet the clause disavowing responsibility for the estimate appears in the contract. The contractor is told he must conduct his own investigations in the six weeks allowed, at most, before submitting his bid, which of course he cannot do. He is bound to be guided by the information furnished by the engineers, and if it subsequently turns out to have been misleading, to a degree entailing additional work and expense, such a contingency should be provided for in the contract.

Engineers who have spent months in taking borings, making subsurface examinations and preparing their estimates know how impossible it is for the contractor to verify this work before bidding, and they should be the first to endeavor to have this clause eliminated in order to allay a sometime suspicion that the low bidder obtained advance information which was withheld from his competitors, and that he got the job because of such exclusive information.

This clause was decided in the contractor's favor not long ago by the Connecticut Courts. The portion of the opinion relating to the legal status of the estimated quantities was very clear. It stated that the representations in the advertisement and the notice as to quantities carried with them "the assertion of being made upon some basis of superior knowledge. Their purpose was to supply information to persons who were expected to act upon it in a business dealing with those who made them, and who were entitled to accept and act upon it as expressing what it purported to express, to wit, information having a basis in such superior knowledge." Elsewhere in the opinion the matter is explained in other words: "It is apparent that the facts involved in the statements and representations in question were such as not to be equally available to both parties, were not at hand or within the observation of the contractors, and involved investigations of conditions, study and computations for which expert technical knowledge was required, if not also a search of the minds and purposes of the members of the Board. They were made by a party in a position to have, and who assumed to have, not only a superior knowledge, but also a knowledge which had a foundation in expert examination and study, and they were made for the purpose of being acted upon, and promptly acted upon."

If this be good law, it only requires a similar case in this State to forever knock out the irresponsible clause.

It is a confession of laziness or lack of faith in his ability for an engineer to insert the provision that if anything has been omitted from the plans or the specifications, which is required to satisfactorily complete the work, such omission shall be supplied by the contractor without extra compensation. Such a clause might also be urged as justification on a contractor's part for evading the specifications in every possible particular, for as a man who had been up against this very clause once observed: "The contractor is justified in safeguarding his pocketbook if an engineer can insert such a clause simply to safeguard his reputation."

There is also the clause vesting in the Chief Engineer indisputable power of interpretation of the contract and specifications, and judicial determination as to their execution. In other words, when a contractor signs his contract, he agrees that the estimate

and decision of the engineer shall be a condition precedent to his right to receive any money under his contract. That is, he waives the right guaranteed him by the constitution of his day at court. As a matter of fact, the Courts have held that it is against public policy to waive such rights, and their interpretation of the clause has been that the decision of the engineer must be limited to the interpretation of the specifications and not to a judicial determination as to the amount of the work or the execution of the contract. The contract contains many clauses that are matters of dispute, not only between counsel for the contractor and the City, but even between members of the Courts in their deliberations, and this clause presupposes that the engineer is a better lawyer than the Courts, or at any rate, makes him paramount. While it is generally thought by contractors that the clause is illegal, it is still retained in many contracts for the simple reason that no satisfactory substitute has yet been discovered.

The methods of arbitration which have been tried have not thus far been as successful as anticipated, either in point of economy or rapidity in settling disputes. One great fault with the system of arbitration generally adopted has been in the number of arbitrators appointed, and when two arbitrators fail to agree the case is presented before an umpire. It would seem to be the better way to appoint only one arbitrator, and to leave his appointment to some impartial body of high standing, such as the American Society of Civil Engineers, and to stipulate a time limit in which each side must present its case.

Another universal clause is that providing that the work may be suspended, without compensation to the contractor other than an extension of the time equal to the period of suspension, and that he may not claim damages for any delays caused by the failure of the City to provide him with the right of way. Since a time limit is put on the contractor, and liquidated damages for delays beyond the stipulated time are deducted from his payment, the City should also agree upon liquidated damages which the contractor may recover for any delay caused by the City, for certainly time is as valuable to him as to the City. Perhaps it is contemplated that these clauses are not enforcible, as they are followed by the provision that *if* the contractor *shall* claim compensation for damages

sustained by reason of any of the acts of the City, he shall file a statement of the amount of his damages before the 15th of the following month or forfeit all right to its payment.

This clause respecting suspension of the work has been altered in the new form of contract recently adopted for highways and paving, the modification allowing the contractor such reasonable expenses as he was put to by the delay or suspension. It has not, however, been changed by any other departments, and the injustice is so palpable that the lead taken by the Board of Estimate's Committee should be followed in all City contracts.

Another peculiar provision is that while the contractor must assume entire responsibility for the safe conduct of the work and the methods of construction, the engineer reserves the right to approve or disapprove his plans. Before obtaining a contract on the Catskill Aqueduct, the contractor must give satisfactory evidence of his experience and ability to undertake the work, and if subsequently the engineers for the City insert their suggestions into his plans for doing the work, should not the City shoulder the responsibility in the event, say, of the failure of a temporary structure? The clause stipulating that the City shall be saved harmless from all damages due to injuries incurred by persons or property, specifies damages due to *negligence* or to the use of improper materials or appliances. If the City approves, the contractor cannot be deemed negligent, or to have used improper materials. Since the contractor is to be held responsible, and has given evidence of his capability, why not let him go ahead in his own way? He is under heavy bond and presumably is as anxious to complete his work as expeditiously as the engineers are—perhaps more so.

The clause relating to sub-surface structures, which appears in nearly all contracts which require sub-surface excavation, is distinctly unfair to contractors. In the Catskill contracts it provides that the structures belonging to public service corporations will be removed and cared for by the corporations, but does not provide a definite time for the removal or any measure by which the contractors may force their removal if the corporations are inclined to delay or refuse, or any guarantee that the City will force such removal. The contract forms now used by the Department of Water Supply, Gas and Electricity, and the Bureau of Sewers, in Man-

hattan, handle the matter no better. They provide that the contractor shall give twenty-four hours' notice to the corporations, and then if the tracks or pipes are not removed, the contractor may remove them at his own expense and must look to the corporation for reimbursement. These corporations are all operating under franchises granted by the City, and that the City has the right and power to order their removal is evident from the following section of a franchise recently granted a railroad company, which is similar to that in other franchises.

"It is agreed that the right hereby granted to operate a street surface railway shall not be in preference or in hindrance to public work of the City, and should the said railway in any way interfere with the construction of public works in the streets and avenues, or upon the bridge, whether the same is done by the City directly or by a contractor for the City, the Company shall, at its own expense, protect or remove the tracks and appurtenances in the manner directed by the City officials having jurisdiction over such public work."

In fairness to the contractor, the City should guarantee to him the removal of all obstructions in his line of work. I understand the Department of Water Supply, Gas and Electricity has prepared a clause which will relieve the contractor from all such responsibility, and the other City departments should follow suit. The subway contracts provide an item for the care of every class of surface and sub-surface structures encountered by the contractor, and provide that the engineers will prepare a plan of rearrangement which is submitted to the interested corporations for their approval—and should the corporations prefer to do their own work, they may do so, but if their work is not done with reasonable dispatch the contractor may proceed with it.

An objectionable clause in the sewer contracts is that giving the City the right to connect any sewer or drain with a sewer under construction, and holding the contractor for the maintenance and cleaning of the used portions until the completion of the entire work. This clause should specify that only the connection could be made, and that the sewer itself was not to be used, otherwise the contractor is entitled to damages, according to a recent Court of Appeals decision on this very clause, which said in part:

"We do not believe that this provision has any such broad meaning as the City seeks to give it. The obvious purpose of it

was to permit connections to be made with the new sewer as work progressed thereon and to avoid the unnecessary disturbance of streets and the expense which would be caused by making subsequent connections, but it did not mean that these sewers and connections should be put into actual use until the sewer was completed. It seems perfectly plain that when one or two sections of the sewer had been completed neither the City nor private individuals would be allowed to drain sewage into it, although the connections were made for subsequent use. The interpretation of the clause is made all the clearer by reference to various provisions in the specifications which did call on the contractor to take care of sewage running through old sewers actually in operation and intercepted by the new one in construction. * * * While the City would not be responsible under this clause because some individual who had been allowed to make a connection improperly turned sewage or water into the new construction, we think it was responsible where, for instance, it constructed catch basins or lateral sewers and put them into use and carried dirt and débris into the sewer while being constructed."

Despite this decision the contracts still provide that the contractor must keep the sewer thoroughly cleaned until completion.

Those are all matters in the contract itself. Considering now the specifications, the sewer contracts define a line of payment for rock, and specify a maximum and minimum line. The contractor cannot receive payment for anything removed beyond the maximum line, and is not entitled to more than actually removed, if inside the maximum line. It would seem only fair to allow full payment for rock to the maximum line whether removed or not. You have all seen instances where the trench broke out much wider than the line for a portion of the work, and on the remainder it was possible to take the rock out with almost vertical sides. Under the contract, the contractor is not allowed for the excess in the wide trench, nor can he average up on the narrow trench by being allowed the full section, which he did not remove. To be fair, a contract should possess some *"give-and-take"* spirit. The Catskill contracts specify a line for payment to which the contractor is allowed, whether the material be removed to that line or not, and I think the majority of engineers will not strictly hold a contractor to the letter in these sewer contracts. The opportunity is there, however, and, unfortunately for contractors, there is sometimes the engineer who considers it his duty to grasp it. Such an

engineer increases the cost of work—not its *efficiency*—for when contractors know he is to be in charge they increase their bid.

Here's a clause in the highway and paving specifications:

"The Contractor shall remove at his own expense when directed by the Engineer, any encumbrances or obstructions on the line of work, located or placed there prior to or after its commencement." In other words, the City does not insure a clear site to the contractor, and under such a clause he could be compelled to remove stone fences or foundation walls, without compensation, even though he had a price for rock excavation. All encroachments, buildings or other obstructions should be removed by the City or the contractor should be paid for their removal.

There are a few things beside those already mentioned which contractors find objectionable in the high-pressure contracts of the Department of Water Supply, Gas and Electricity. They think, for instance, it is a mistake not to allow the contractor to furnish all the material for the work. The hydrants are furnished by the City, and if they are not forthcoming when the contractor is ready to set them, it means delay for him. Must he fill in his trenches and continue with his work and then when the hydrants do arrive, go back and reopen the trench, all without extra compensation? He has been asked to do so. The City invites trouble for itself [illegible] by furnishing hydrants. Suppose one being hauled to the work [illegible] damaged, who damaged it, the contractor [illegible] or was it imperfect when it left the yard? When [illegible] the contractor all these questions are avoided.

The [illegible] includes the concrete base [illegible] and all [illegible] which are encountered [illegible]. There is a big difference in the cost of removing [illegible]. The [illegible] concrete costs about $5 [illegible] per yard, and moreover, [illegible] foundation [illegible] in advance how much [illegible] be two classes of [illegible].

[illegible] are [illegible] contractors from [illegible] the [illegible] a shut-off, to permit

connection to be made. It is but slight satisfaction for the contractor to know *his time* will be extended, when he has had to pay his men full time, waiting for the Department to make the shut-off. Then there are the tests to which the joints are subjected, 450 lb. for high-pressure work. That is all right enough for the new work, but when it joins on an *old line,* the contractor should not be required to furnish pump capacity to overcome the leaks in the old work. The City should test the existing section to which the new joins, and make such allowance for leaks as may be necessary.

These are trifling things; perhaps none of them would make or break a contractor; but in the long run they amount to considerable in dollars and cents. When, however, an opportunity presents itself where a contractor might get it back by some concession, is it granted? Not often. When I say concession, do not understand me to mean permission to skin the work, but there are many ways in which an engineer can allow a contractor to make up his losses without the slightest injury to the work or deviation from the specifications. A case in point: a contractor was required to haul his excess pipe to a certain yard at his own expense, or, if hauled elsewhere, he was to be paid his bid price per ton mile. The yard designated in the contract was crowded, but instead of allowing him to haul to a distant yard and be paid for it, the engineer ordered it delivered to the first yard, where there was no room, and *another* contractor hauled it away to the other yards.

Then again, there is the engineer who takes advantage of the contractor's unit prices, and omits or orders in certain items dependent on their bid prices. Probably every contractor of any experience has met the engineer who required him to put in several thousand feet of timber when his bid was one cent, on a nominal amount, or when he had a good price on a large estimated quantity, scarcely any was required. Of course that is the penalty for making an unbalanced bid, but the contractor is required to gamble on so many contingencies that he is often excusable for taking a chance that the engineer will give him the best of it once in a while.

Some engineers are too narrow to realize that a specification is a *standard,* and that an approximation to that standard fulfills

the contract. The man who rejects masonry because the joints deviate a fraction from the specification, or piles because they are a half-inch under size at the butt, doesn't appreciate that he is standing in his own light. He never becomes a big engineer; he never has *time to learn engineering,* he is too busy inspecting.

The views I have expressed are not only those of contractors. I know that many engineers among you agree with them. In preparing this paper I asked the members of the Association to send in their suggestions, and I received not only suggestions but many grievances. You know contractors are terribly averse to talking about their troubles in public, and I will, therefore, omit names in reading to you a few of these communications, which are typical of them all. The first is interesting as showing how hard it is to get the money after the work is done. Contractors are not philanthropists, that is, I have not met any who are, but they are willing to stand for most anything provided they can be sure of prompt payments.

One member writes: "It might be as well to call the attention of the Municipal Engineers to the unfair conditions which often arise in City contracts due to the clause providing that for every day the contractor is delayed by the City he shall be entitled to one day's extension of time and nothing else. In the case of the New York Public Library, our contract amounted to over $3 000 000. We were prevented from completing our work because the City let another contract for work which had to be done before we could proceed with the remainder of ours. As our contract was practically completed, our retained percentage, amounting to $450,000, was held for a period of four months, but eventually an arrangement was made with the City whereby we were paid all but $12,000 of the retained percentage, and our bond for the execution of the contract was proportionately reduced. In addition to the loss of interest on $450 000 for four months, we were required to make good any defects in the work which might appear within a period of *two years after the receipt of final payment.*

"Since we were unable to complete the engine room, due to the work of other contractors, until May of this year, we have not yet received the final payment of $12,000. We have been making a number of repairs since April, 1910, when our contract was en-

tirely completed except the engine room, until May of this year, when it was also completed. The question now arises as to when the two years' guarantee shall begin. Should the date be when we receive the final payment of $12,000, now due, or should the date go back to April, 1910, when we had practically completed our contract and refrained from doing the small balance of work in the engine room as an accommodation to the City? Under such conditions you can appreciate that an extension of time of only one day for every day that the City delays the contractor *is not* adequate compensation for loss suffered."

In another letter in reference to this same public library, another contractor says: "There has been no friction or criticism of our work at any time, but in spite of the fact that the library has been opened to the public for about six months, and the City has had the use of all our work, we have not been able to get our final payment. The principal difficulty seems to be in having the work properly inspected. Instead of having one thorough inspection, which should be sufficient, our work has been inspected by the architects, by the consulting engineers, by the Department of Water Supply, Gas and Electricity, by some other City departments, the name of which we do not recall, and finally, after all these inspections, still another one is now going on under *another* consulting engineer for the City. In each inspection trivial things were brought to our attention, which were corrected, but there does not seem to be any end of the inspections. It seems to us that this work could have been inspected as it progressed, and if any fault were to be found we should have been notified at that time instead of letting the present complex state of affairs arise. It also seems to us that there should be but one inspection, as thorough as the City could devise, and once it has been made and any changes recommended carried out, we should be paid. While we may have a case against the City for delay, and eventually receive all of our money, the present state of circumstances is most unfair and unsatisfactory."

These letters must strike a responsive chord in the mind of every contractor, and apparently the only excuse on the City's part lies in the wording of the contract, which provides that the final payment shall be made within a certain time after the *acceptance*

of the work, and between completion and acceptance there is often a long delay, the reason for which is not apparent to contractors. The contract should stipulate a reasonable period after the *completion* when the final payment is to become due, and allow interest if the payment is not made at the stipulated time. The interest clause for delayed payments is allowed in the Catskill Aqueduct contracts and has also been inserted in the recently adopted standard contracts for highway and paving work by the Committee of Engineers appointed by the Board of Estimate. It is a clause which every contract should contain and one which was advocated in nearly every letter sent in by members of the Association.

Another contractor expresses himself in regard to the disclaimer of responsibility clause, in these words: "We wish to register a general protest against the engineers taking months to get up a scheme and having all the facilities at their fingers' ends for obtaining information, getting out quantities and schedules of work to be done, and then, without any compunction, saddling the contractor with the necessity of getting out an estimate at short notice and loading him with the responsibilities which the engineer should take care of, in many cases going to the length even of making the contractor responsible for the engineer's design."

Another member says, in relation to the same clause: "The City of New York should make its estimates on more definite quantities and measurements. Under the present conditions we believe that it is possible for a favorite contractor to know when things are sometimes called for that will not be used on the work, thus enabling him to unbalance his bid and secure the contract, whereas a contractor who is bidding an honest figure for each item will lose the job." This contractor also believes that a more definite arrangement should be made in the matter of permits issued to contractors, and that the City should secure for them all necessary permits from its own departments, and also from public service corporations. He believes that the water-pipe contracts should contain an item for additional special castings and pipe requiring lugs, for while the proposal does contain a price for these items, the quantity, if increased, will necessitate the contractor ordering an extra amount which he may not get for as low a figure as the original order.

An instance of how an inexperienced and finicky engineer can hamper the work is contained in another letter relating the writer's experience on a contract calling for a large amount of concrete. The assistant engineer noticed two carloads of gravel ready to dump into the hoppers of the mixer. One car contained white gravel, while that in the second car was of a reddish-brown tint. The engineer rejected the second car on the ground that the concrete would be a light color where the lighter gravel was used and dark where the darker was used. It took some days to have this matter adjusted by the chief engineer, who overruled his assistant, with consequent hard feeling on the latter's part. This same engineer refused to allow the mixing machine to work because the sprocket in a certain part of the mixer was stamped No. 8, when according to the catalogue it should have been stamped No. 7. It was demonstrated that this was a factory error and had not the slightest bearing on the output of the mixer, as shown by the measuring boxes giving the proportion required by the specifications. In spite of this proof the engineer argued that the mixer was not *theoretically correct,* and the chief engineer had to be called in again. This contractor, in conclusion, states that a man can hardly be blamed, after suffering a loss of some hundred or more dollars just through lack of practical knowledge in the engineer, for grasping an opportunity where he can skimp on his cement or some other part of the work in such a way that it will not vitally affect its stability, to recover the loss to which he has been needlessly put.

In specifications which deal with manufactured goods it is absolutely indispensable, in order to secure reasonable provisions, that on certain technical points the manufacturer should be consulted. Some of the tests to which materials must be subjected have been oftentimes declared impossible or unreasonable. One of our correspondents has the following criticisms to make on the specifications for high-pressure work issued by the Department of Water Supply, Gas and Electricity: "We believe that the specifications for the composition for seat rings is erroneous, as such an alloy as specified would not be suitable for seat rings, although it would be entirely suitable for disc rings. The requirement that cast iron shall be entirely free from uncombined carbon, when

seen under the microscope, is impracticable and difficult, if not impossible to be governed by inspection, and also immaterial if the physical properties or the strength tests are complied with in the mixture of the iron.

"The difficulty that the manufacturers have found in the specification for nickel steel lies in the requirement for elongation and contraction of area, since high nickel steel containing from 21 to 24% of nickel is but slightly affected by thorough annealing. The condition of the forged metal depends more upon the treatment it has received under the hammer than any subsequent treatment from annealing or quenching. The specifications are 80 000 lb. tensile strength, 40 000 lb. elastic limit, 22% extension, and 32% contraction of area. Under these specifications a great deal of the material would fail, but if they are modified so as to require 70 000 lb. and 35 000 lb., with 15% extension and 15% contraction, the material would be amply strong and suitable for the purpose intended, considering the factor of safety and size of stems specified in a subsequent paragraph.

"We believe that the absolute prohibition of plugging, cementing or stopping up all trifling holes or faults in castings is a mistake. These things should be allowed under the engineer's supervision, in accordance with well-understood and established practice in general lines of business for castings under hydraulic pressure.

"The specifications require drawings of valves to be furnished by the contractor. This is inconsistent with the paragraph which specifies that the valves shall be made in accordance with the drawings on file in the department, which are complete in all details. Since the department already specifies the types, materials, construction and operation according to such drawings, why should the contractor be required to submit other drawings, thus causing confusion and delays? The paragraph relating to the types of valves seems to be inconsistent with the standardization policy adopted by the department, as evidenced in other valve and hydrant specifications, inasmuch as an alternative is given for two different types of valves. While this may have been an object in the early stages of high-pressure practice, in order to provide an opportunity to study the two types, the valve decided on, after observation of both types on the first high-pressure contract let, was the single

disc wedge valve, since which time there have been furnished over 4 000 valves of this type only, which have proved entirely satisfactory. To allow a double disc valve would destroy the interchangeability and standardization generally aimed at and so desirable for replacements, renewals and repairs. We would therefore suggest that the reference to the double disc valves be eliminated. We would also suggest that the reference to the by-pass on the 6-in., 8-in. and 12-in. valves is misleading since they are not used on those sizes.

"The same objections to the specifications for the high nickel steel are applicable to the non-corrodible metal, except as to annealing, forging and quenching."

All of the worst things, however, are not to be found in New York contracts. If a contractor signs away his constitutional rights here, just see what he has to subscribe to in Toronto. They are thinking of building a subway up there and they want to make sure that the right man does the work. Just listen to this:

"If the contractor shall neglect or refuse to sign the plans before commencing work, or neglect or fail to commence preparations for work within ten days, or fail to commence actual construction within sixty days after the date of the engineer's order to commence, or if he shall become bankrupt or insolvent, or compound with his creditors, or commit any act of insolvency, or shall transfer, assign or sublet this contract, or any part thereof, without the consent of the engineer; or if at any time the works, or any part thereof, is, in the judgment of the engineer, not executed or not being executed in a sound and workmanlike manner, to his satisfaction in all respects in strict conformity with the contract, or if the work or any part thereof, is not progressing continuously and in such a manner as to ensure its entire completion, in the engineer's judgment, within the time stipulated, or if the contractor shall refuse or neglect forthwith, when so ordered, to conduct the work so as to ensure its completion, in the opinion of the engineer, within the time stipulated, or if the said time has expired and the work be not completed, or if the contractor shall refuse, or neglect, to take down, rebuild, repair, alter or amend any defective or unsatisfactory work, or to remove any condemned material or workmanship or to comply with any reasonable order he may receive from the engineer, or if the contractor shall persist in any course in violation of any of the provisions of this contract, then, in each and any such case, after twenty-four hours' written notice from the engineer, to the contractor, the engineer shall have the full right and power at his

discretion, without process or action at law, to take the whole work, or any part or parts thereof specified in the said notice, out of the hands of the contractor, and the contractor upon receiving notice to that effect, shall vacate possession and give up the said work, or the part or parts thereof specified in the said notice, peaceably to the engineer, *who may either re-let the same to any other person or persons, with or without its being previously advertised,* or may employ workmen and provide materials, tools, transportation and all other necessary things at the expense of the contractor, or may take such other steps as he, the said engineer, may consider necessary or advisable, in order to secure the completion of the said work to his satisfaction."

Yet there will be contractors who will subscribe to such a document. They are the most trusting people in the world—contractors. They gamble with equal cheerfulness and optimism against the elements, against accidents and on the estimated quantities and your treatment.

The subject is too broad and complex to be covered in any one paper or to be fully discussed at any one sitting. I know that the points I have mentioned reflect but a small part of the contractors' views, and doubtless you will take issue with much that I have said. But bear in mind just this thought, contractors and engineers are mutually dependent, and since you need them in your business, don't try to put them out of theirs.

DISCUSSION.

HENRY W. VOGEL, M. M. E. N. Y.—Mr. Crane stated at the end of the paper that this is a subject which would require more than one evening to hear only the contractor's side, many more, probably, to hear the engineer's side, and then possibly other evenings to discuss the questions involved.

It might be well, before we hear the discussion, to have questions which may have arisen in the minds of any member, answered by Mr. Crane—it might shorten the discussion. Has any member a question to ask Mr. Crane? They all believe you unquestionably, Mr. Crane.

Perhaps it would be well now to hear the engineer's side. Mr. Tillson, have you something to say?

GEORGE W. TILLSON, M. M. E. N. Y.—I must say that in the main I agree a great deal with what the author has said. There is considerable truth in many of the objections that he has made to the form of City contracts, and there are a great many good reasons for those things being placed in the contracts.

It has always seemed to me, and I have always tried to carry out the idea in making up plans, specifications and contracts, that the specifications should show to the contractor just as clearly as possible what work the City wanted done, and that the contract itself should be drawn in as simple and concise a manner as possible so that the contractor will be obliged to do what is required.

In the City of New York the contracts and specifications are probably as complex as those of any other corporation, whether private or public, notwithstanding the quotation that the author gave from the Toronto specifications. Our contracts are made on exactly the principle, that they must be for the just and the unjust, the good and the bad; they must protect the City against the bad contractor just the same as the laws of our country must protect all our citizens.

Our contracts, in their complexity, have been brought to the point where they now are, by the decisions of courts against—I will not say irresponsible—contractors who were endeavoring to get everything they could out of the City on technicalities, without regard to the real justness of their claims. Every good engineer wants a good contractor, and as a general proposition it is fair to say that every good engineer will have a good contractor if he be unrestricted in his choice, but, owing to our law, we are bound to give the contract to the lowest bidder, unless there is some good reason against it, and it is the irresponsible contractors who have brought our New York contracts down to the condition in which they now are, because there have been so many decisions rendered

against the City on account of technicalities, in which there was no justness at all, that the Corporation Counsel has put into the contracts conditions which will prevent any of those decisions being repeated.

The author spoke about the fact that the engineer is the man who shall decide all questions, and at the same time, and almost in the same sentence he admitted that nobody had ever found a better plan; but why should not the engineer be the better man? Who is better able to interpret the specifications? The people who are paying for the work are the ones who should decide whether the work is done according to the specifications or not, and it must be left to some one; it should be left to the engineer. When a question comes up on the street, the decision cannot be left to arbitration. There must be somebody who has the right to decide it at the right time, and who is a better man to decide it than the engineer? I think the contractor himself, ninety-nine times out of one hundred, will say that the engineer is a better man to decide it than the Commissioner, if there be a Commissioner, or the Board, if there be a Board. The contractor wants as little delay as possible, and it is generally less expense to him to have a question decided promptly, perhaps in a little different way from what he wants it, than to wait and have it settled later exactly in his own way.

I would like to give the history of the clause in the contract which says that at the end of five years the pavement shall not have a depression greater than ⅜ in. under a 4-ft. straight edge. That clause was not formed in New York, or by any New York Department. I happen to know something about it. When asphalt pavement was first introduced, it was necessary for the asphalt companies to say that they would lay a pavement and keep it in good repair for five years at their own expense. The contracts were drawn in those words. The question naturally came up at the end of five years—what was "good repair" and who was to decide whether it was in good repair or not. Was it in bad repair when water "hesitated" on the street, or was it in bad repair when there was a depression of ⅜ in. under a 4-ft. straight edge? Twelve or fourteen years ago a committee on pavements of the American Society of Municipal Improvements took up that question in detail and corresponded with almost every asphalt company in the country of any note, and certainly with the largest company, and that specification, that clause, was made up after consultation with the engineers and the experts of the different asphalt companies in the country. I know that personally, and it is absolutely necessary, in order to avoid any trouble at the end of the guarantee period, that there should be some definite clause to determine whether the pavement is or is not according to the contract.

The author says the contractors are very trusting. They are. They are so satisfied with their ability to do the work profitably that they are willing to take chances, and while, of course, some contractors do fail, and I do not doubt that some contractors do fail on account of wrong work on the part of the City or on account of the actions of the City that are not right, still the majority of contractors do make money. It has been my experience, and I never could understand it, that when you get into court, the jury and the general public will believe the contractor and his representatives sooner than they will the representatives of the City. That may seem strange, but I have seen it time after time. With the contractor it is a matter of dollars and cents in his own pockets, and to the engineer that reputation the gentleman alluded to in his paper.

While I believe there are undoubtedly a great many things in the contracts of the City that should be changed, and there are a great many things that the engineers would like to see changed that they cannot have changed, yet, as a whole, I believe that the contracts of the City are carried out in almost every case with the spirit of fairness between the engineers and the contractors, and that the old feeling that existed twenty-five or thirty years ago, when, if an engineer were on friendly terms with the contractor it would seem he were standing in with him, is done away with. I believe that the City gets better results because there does exist this feeling of—you might say good fellowship—between the contractor and the engineer. They are both working for themselves and both intending to do good work, and the results will be better in every way if the contractor and the engineer are working together in harmony. Under such conditions there will then be no such decisions as that of which the author spoke in regard to the mixer for concrete, and the contractor will not be inclined to slight his work by putting in a less amount of cement to get even on account of some unjust decision of the engineer.

Henry W. Vogel, M. M. E. N. Y.—Mr. Crane, in the early part of his paper, referred to a paper read before this Society by one of our members, Mr. John C. Wait, who now represents neither the City nor the contractor's side; possibly he leans towards the contractor's side. Perhaps Mr. Wait will supplement what he said five or six years ago and add something to the discussion of the evening.

John C. Wait, M. M. E. N. Y.—Mr. President and fellow members: It has been some time since I have had the pleasure of appearing before you, and now I am in a new position and I do not know whether I had better take the engineer's or the contractor's side of this problem.

For four years I represented various departments in the Corporation Counsel's office, as assistant and as acting Corporation

tried to prepare, with your assistance, some contracts
ns which would be acceptable to you. I believe those
some slight modifications, are still used, but the
re not. The contracts have not been changed in any
w of, but I have noticed a great improvement in the
which is largely due to members of this Society.

ngs which I have noticed in the contracts, one is the
e. When I came to the Corporation Counsel's office,
use that if the contractor failed to complete the work
e by the City, the contractor forfeited all the profits,
ey which was left in the hands of the City, because
d. That seems unreasonable, because the contractor
most completed his contract, say within 10%, and
the rest of the work he would sacrifice all his profits.
s stricken out at my suggestion as being improper
t has been restored, but I doubt if it will hold in
a wrong to contractors.

the Highway and Water Supply Department con-
t between the City and public service corporations,
know how you are going to meet it. The trouble
to politicians and elected officials. Engineers are
see many officials come and go. It is very difficult
ers to get the public officials under whom you work
matter. It is very difficult to get the public service
take care of their public service structures, and the
lict between the City and the contractors. The con-
he public officials to make the public service corpora-
of their structures and the City's officials don't want
has got to be worked out by legislation.

e to-night to learn and to listen; to learn what
king place and especially to hear Mr. Crane's paper.
here to instruct anybody. The last time I came
I picked out "The Engineer's Faults." It was replied
nd I said enough then upon that subject.

thing I wish to commend and that is the organiza-
d of consulting engineers. I understand that the
of the Borough Presidents' offices have been con-
d of expert engineers and that they have joined
reparation of a general specification. That will, in
d to excellent results.

ifferences constantly arising between the contractors
ers, and there always will be. As Mr. Tillson says,
le to decide them than the engineer? I would answer
that there are many engineers in the employ of the
the experience of some of the older men, not only

engineering experience but business experience, would enable them to better decide disputes. You prepare a specification—you idealize it and you make it as perfect as you can. Every single thing is considered and studied for the very best practice, and the specifications are drawn for ideal work. Can you get ideal work in your practice? I do not think you can. You know perfectly well that the quality of your stone and the condition of it will affect the amount of cement that you should use, and when you draw a perfect specification the conditions of the work are affected by conditions and changes, and some indulgence sometimes would benefit the contractor and make just as good work. I would suggest that you carry the idea of a board of engineers a little further. If the municipal contract would provide for an appeal to an Appeal Board of the older and more experienced men of this Society, and they should arbitrate disputes between the contractor and the City, it would be better than to leave it to some engineer who, though conscientious, was trying to carry out ideal specifications to the letter. Would not that be an improvement? An unbiased board of three would be much safer to pass upon the disputes between the City and the contractor than the engineer in immediate charge.

It is my regret that your board of engineers should be attacked, as it has been in one instance, by taxpayers. Taxpayers expect to prevail notwithstanding the recommendations of the board. That is one of the things you meet with—constant interference of politicians, taxpayers and the public. You engineers may decide a thing is best. You are then approached, not by the contractor always—but by some politician or taxpayer, or by some one who is active in the introduction of their goods, and are told that the Hon. So-and-So would like to see it put in. If your board of engineers decide upon a certain class of pavement for a certain street, after a thorough investigation, why is it permitted to be set aside, against the interests of the City at large, to please some real estate operators in a limited local district? I ask why, except to curry favor?

My friend has taken up a number of familiar topics, and has touched briefly upon one subject which I have mentioned before and which I want to mention again. We have sub-strata or subsurface conditions as for foundations. I have known in government and municipal work of instances of engineers spending many thousands of dollars to make borings and soundings, and then declaring in the advertisement that they do not know anything about the substrata, and that the contractor must determine it for himself.

When you have determined such conditions to the best of your ability, and at great expense to the municipality, why shirk the responsibility because you may have made a mistake, and why make an insurance company of the contractor? He knows nothing about

it, while you know all about it. Better have an error once in a while and let the City shoulder it and reduce the expense of much work, and save the City hundreds of thousands of dollars which are now expended by the contractor in insuring your jobs. When you have prospected the site of the work you should stand by the results. Give the results of your work and say the City has made its investigation and it knows the conditions and is willing to stand the expense. It is a matter that must sooner or later be corrected.

Mr. Crane has evidently been in very close touch with contractors and he has heard their side of it, and I agree with a good many things he has said, but, as Mr. Tillson says, there are good contractors and bad contractors. I do not know how you can distinguish.

I think you engineers have all the powers that were read in the Toronto contract. If you read the general powers granted, and not take them in detail, you will find you have the same powers in our City contracts.

The interest on the money which is being allowed to contractors as being a feature of some of your new contracts is interest of 4 or 4½% in the public service or water supply contracts. This may be a boomerang to the contractor. A contractor goes to the bank when his money is held by the City and says, "I want $60 000." The bank official says, "Very good, Mr. Jones, we will let you have $80 000 and give you a drawing account of $60 000." The result is that you pay 6% on $80 000, which is 8% on your available drawing account. Without that provision in your contract the contractor would get at least 6%, which is the legal rate, whereas he gets only the 4% or 4½%, losing 2% or 1½% by having that clause in the contract.

I wish to commend Mr. Crane for his paper. I could not help but look about the engineers, however, and see the expressions on some of their faces while he was reading the paper. One could trace the experience of individuals as things recited came to the attention of some of you who did not agree with him altogether. This, of course, is a live subject to me and it is a pleasure to address you, and I have to thank you for your kind attention.

HENRY W. VOGEL, M. M. E. N. Y.—When I came in this evening, I was introduced to Mr. Diebitsch of the John Pierce Company. We would like very much to hear from him.

EMIL DIEBITSCH.*—Mr. President: I have not the honor of being a member of this Society, but I have had the pleasure of meeting a number of its distinguished and active members, particularly the active member who manages the advertising pages.

* Vice-President, John Pierce Company, 90 West St., New York.

The subject of Mr. Crane's paper, Municipal Contracts, is one which forms the very foundation of the municipal contractor's business, and while I have for a number of years past always looked at these instruments from the contractor's side of the fence, nevertheless I have an appreciation of the engineer's difficulties in drawing up contracts and specifications, and in seeing that they are lived up to, in spirit at least, if not in letter, by the lowest responsible bidder.

This viewpoint I gained, not so much in my less degenerate days, when I was an Assistant Engineer and Inspector in the U. S. Navy Department, as in my present position where, as general contractor, a most important part of my work lies in drawing up contracts with material men and sub-contractors, and afterwards seeing that the provisions laid down in the contracts are adhered to. I know from experience how much delay and trouble can be caused by an argumentative contractor and how innumerable are the loop-holes which he tries to find in the most carefully drawn contracts. For these reasons my sympathies lean toward the engineer and I understand why he draws his contracts so rigidly and gives himself such absolute power.

Moreover, I have a broad faith in the honest intention and fairness of engineers, which influences my judgment when considering a prospective contract, and sometimes causes me to take risks which a less optimistic man would not assume. My experience, however, has not caused me to change my opinion or to reduce my optimism, for I have found that when apparently drastic clauses occurred in the contract there was either no occasion to apply them, or, if applied, they were usually interpreted by the engineer in a fair and reasonable manner. I say "usually" advisedly, for there have been cases where it took the Court of Claims to measure out the justice which the engineer should have given us in the first place.

Despite these exceptions, I agrée with Mr. Tillson that the Chief Engineer in charge of a piece of work is the best person to interpret the plans, specifications and contract, for very often the Chief Engineer is the father of the plan and has sat up nights with the specifications and contract. He certainly knows better than any one else what the plans and specifications are intended to show, and if, through some oversight, he has failed to express clearly what was intended, he is as likely to be fair and reasonable as any one else in interpreting the clause or paragraph in question.

It is because I believe that the Chief Engineer in charge is best able to pass upon the plans, the contract and character of work done that I maintain that it is unfair to him and to the contractor to have a second engineer reinspect work which has been reported as satisfactory by the Chief Engineer. Yet I believe it is not un-

common for the engineers of the Finance Department to hold up payments until they have examined the work covered by the Chief Engineer's certificate, and to insist that such work be made satisfactory to them before passing the certificate to be honored by the Comptroller. Such action would indicate that the Comptroller's engineer, not the Chief Engineer in charge, is the final interpreter of the requirements of the contract.

This is unfair to the Chief Engineer, for it reflects upon either his integrity or his ability. It is unfair to the contractor for it subjects his work to double inspection, and somewhere it is written as a fundamental principle, that no man shall be put in jeopardy twice for the same offense.

It has sometimes occurred to me that it would be advisable to require every engineer or architect, who has authority to issue a certificate, to give a bond in such form that the City could collect from his bondsmen any money paid out on a certificate improperly issued. This would relieve the Comptroller of financial responsibility for funds so misapplied and might do away with the present re-inspection by the Comptroller's engineers, or the special engineers of some department.

The case I have in mind at this moment is the contract for the interior finish of the New York Public Library. This document stated very clearly that the architects should be the judges of the character of the materials and workmanship furnished by the contractor and their certificates were honored without question, until more than three millions of dollars had been paid to the contractors. When the final certificate, in amount $13 000, was issued, the Commissioner of Parks delayed signing it until his own architect had inspected the work. Many points were raised by this architect and the payment of the certificate was delayed from its date of issue in May, until now and perhaps longer. All persons engaged in this transaction are of unquestioned probity and ability, and are evidently desirous of treating the contractor fairly, and yet he does not receive the money due him for the work done in accordance with plans and specifications to the entire satisfaction of the judges selected by the City to pass upon the work. This is manifestly unfair to the contractors, and some remedy should be provided against a repetition of similar cases.

Another criticism which I think can be fairly made against municipal contracts is the failure of the City to make payments as agreed within thirty days after the certificate of the engineer in charge of the work has been issued. It seems to me that there can be no question on this point. The City should pay within the thirty days stipulated, or if experience shows that it takes sixty days to check and counter-check such certificates, then the con-

tract should state that payments will be made within sixty days after the certificate is issued, and they should be made within that period of time. If, for any reason, payment cannot be made within the time stipulated, then the City should pay the contractor interest in full at the commercial rate for the time that the payment is delayed.

In the contracts made by the Board of Water Supply, it is stipulated that the contractor is to receive 4% or 4½% interest on money which is not paid when due. While this is a long step in the right direction, it is interesting to note the bias of the engineer's mind in determining the rate of interest. Evidently he reasoned that as the City can borrow money for 4% or 4½%, that was all it should allow the contractor. It probably never occurred to him that the contractor, failing to get his payment as stated in the contract, would have to borrow from the bank at the commercial rate and therefore lose 1½% to 2% on his money, because the City had failed to provide funds.

There can be no question that the rate of interest payable by the City should be the commercial rate which the contractor has to pay, and as this is a higher rate than the City has to pay for its money the additional cost should serve as an incentive to the City to provide funds and make payments promptly.

There are many other points in City contracts which could be discussed by the City's engineers and the contractors to the advantage of all, but enough for to-night. I have been much interested in this paper and am greatly pleased by the attitude of open-minded interest taken by the members of this Society.

HENRY W. VOGEL, M. M. E. N. Y.—Another member of our Society, whom we are always glad to see, but who does not often attend our meetings, is here. Major Smith, will you say something?

MERRITT H. SMITH, M. M. E. N. Y.—Mr. President and gentlemen: I am inclined to think that it might be better for engineers to think about Mr. Crane's paper than to discuss it.

Mr. Crane did not suggest just what the solution of the various problems might be, and as I have the pleasure of Mr. Crane's acquaintance, I intend to ask him. I think if all the Municipal Engineers went down to their offices to-morrow morning and wiped out all the objectionable clauses of which Mr. Crane speaks, that the Municipal Engineers probably would cease to exist. While that is no argument against righting a wrong, it would not accomplish the results in which Mr. Crane is interested, because their successors would probably restore the clauses and the situation would stand where it was before. I believe that it is important for engineers to think out their problem, so that they can get the cooperation of contractors. You and I have seen whole sections of

this City made uninhabitable by delayed contracts. Some of this is not our fault; some of it may be. If a contract let meant a public utility secured, perhaps we might find some defence for putting clauses in our contracts which are one-sided, as Mr. Crane suggests some of our clauses are. When it is considered that we are endeavoring to produce an agreement under which two parties are to co-operate toward the completion of public works, it is well worth our while to consider what clauses are fair and how our contracts can be improved.

It is suggested by Mr. Crane that engineers, at times, are inclined to be unfair in the interpretation of the contracts under their charge. If that is so, it seems to me that engineers should think that matter over very carefully, because undoubtedly they are in the position of arbitrator between two contracting parties and it is absolutely for them to see that that arbitration is fair.

I was very much interested in Mr. Crane's paper. It is a subject that should interest every engineer. Mr. Crane presented it well, as he always does any subject which he undertakes to handle, and I think it would be well for every engineer, young and old, to consider the solution of this problem which he presents, with the utmost care.

Henry L. Oestreich, M. M. E. N. Y. (by letter).—The experience of twenty-odd years as engineer in county and City service leads the writer to disagree with some of Mr. Crane's conclusions and to agree with him in regard to others.

The engineers should make the specifications in the same City departments uniform for the five boroughs. Contractors and manufacturers should then be invited to a conference to give friendly criticisms.

Since the approximate quantities given with the invitations to bid are usually correct within 5%, why should not the contractor be glad to use them as a check on his own figures? Why should the City bind itself for a possible clerical error in the preliminary estimate of one of its engineers? The contractor, being paid for work actually done, and not according to the preliminary estimate, does not suffer except in the case of an unbalanced bid. Would Mr. Crane rather have no preliminary quantities at all, unless "guaranteed"; or would he have the quantities and prices fixed by the engineer, and have the contractor bid on a percentage of the whole estimate? I disapprove of the latter method, because the contractor should be the one to determine not only at what price he will do the work, but within reasonable limits, the relative values of the items.

A certain contractor bid on regulating and grading of three streets. Some of the prices in each bid were too low if they were

taken individually, but, since he happened to win on the three bids, and used the excess rock in one street to build walls in the others, etc., the three bids taken collectively were not unbalanced, and the City was fortunate in getting work done cheaply.

The contractor does not always use the preliminary estimate even when it is correct. A certain contractor made a lump-sum bid on a piece of work in which the preliminary estimate included an item for 6 000 tons of steel. A well-known steel company estimated it for him as 7 500 tons, which quantity he used. Since the preliminary estimate was correct the contractor's bid would have been $120 000 too high if he had not, fortunately, made a clerical error in another item which nearly balanced the mistake.

Some contractors do not take specifications as seriously as does Mr. Crane. When the writer handed a prospective bidder for railroad work a copy of the specifications, the latter said, "Let me have the profile and the quantities. It is many years since I read a specification. I don't need to. I know how to do the work!"

A number of years ago a firm having a contract to place waterproofing in accordance with standard practice, offered as a substitute their own specification calling for different materials and methods. The substitution was agreed to. It was immediately found that the contractor's men used only one-half of the more expensive ingredient called for by their specifications. This was not denied by the contractor, but the claim was made that it was impossible to use 100% more of this ingredient and make a good job. The same specifications had been used by the same firm on other large jobs in large cities, but had never been followed. Contractor's experts were on hand to prove that the specifications were never followed. The work was completed, however, in accordance with the contractor's specifications, and made a good, tight job. Here was a case of the contractor furnishing his own specifications, and yet refusing to follow them.

Those who interpret the laws are more powerful than those who make them; the same is true of specifications. The engineer often has to leave much of the inspection of work to inspectors of masonry. The writer has had some honest, competent inspectors, men who were a real help on the job, worth double the salary they were getting. He has also had as inspectors of masonry men voting the right ticket and whose qualifications were years spent as watchmaker, dairyman, barber, dancing-master, etc. These were not dishonest men or grafters; they were the personification of good-natured stupidity.

William W. Brush, M. M. E. N. Y. (by letter).—As the title of Mr. Crane's paper indicates, the viewpoint presented is that of the

contractor, and as is the case with any advocate, Mr. Crane does not attempt to present the other side of the question.

In preparing a New York City contract to-day there are so many interests to be considered, as well as legal restrictions, that it is difficult to obtain a form of contract that will seem fair to all. The general procedure at the present time is as follows: The contract and specifications are prepared by the engineer, submitted to the head of the department for approval, sent to the Corporation Counsel for approval as to form (this usually involves a more close scrutiny of the language of the contract and specifications than would naturally be inferred from the wording of the Corporation Counsel's approval), and then sent to the Board of Estimate and Apportionment for approval, which usually means examination and criticism by an engineer of the Finance Department. After having passed through these various stages, the contract is ready for advertising.

The natural query is: Where are the contractor's interests considered?

Answering, I should say that normally they should be, and are, considered by the engineer who originally draws the contract and specifications. It is doubtful, however, whether the contractor's viewpoint receives the consideration that should be given to it, and I would suggest that the practical way of obtaining better contracts would be to have standard forms of contracts and specifications adopted by the Board of Estimate and Apportionment, after having the matter thoroughly considered by a committee consisting of a representative of the Corporation Counsel and an engineer from each of the following City boards and departments: Board of Estimate and Apportionment, Finance Department, and the department or departments interested in said contracts and specifications. The views of the contractors, as well as of the public service corporations, should be obtained from the parties interested, the contractors probably being best represented by the General Contractors' Association, with which Mr. Crane is connected. It is possible that the Municipal Engineers, as an association, could aid in this standardization work, although it would require careful consideration to decide in just what manner its interest could be expressed, owing to the fact that the members of the Municipal Engineers are also employes of the various City departments.

There are a few specific points raised by Mr. Crane, which, I believe, should be discussed from the viewpoint of the engineer employed by the City.

The suggestion of having an arbiter appointed to settle disputes, and having that arbiter chosen by some outside body not under the City's control, such as the American Society of Civil Engineers.

would be of doubtful legality, and in fact, as Mr. Crane states, the reference of questions in dispute to arbitration has not been uniformly successful. If the principle of arbitration is to be adopted, an arbiter agreed upon between the contractor and the Board of Estimate and Apportionment would be more practicable.

The question of the relations between the contractor, or public service corporation, and the City is one which the City engineer feels should be modified and made more definite, and I believe that all concerned would gladly co-operate in making this change.

Mr. Crane criticizes the Department of Water Supply, Gas and Electricity for furnishing a portion of the material for the work, instead of having the contractor furnish all material. Where the City can obtain material more satisfactorily direct from the manufacturer and deliver the same to the contractor, there is, apparently, no reason why it should not do so, but the City should certainly be responsible for any loss the contractor suffers, due to the City not being in position to furnish the material to the contractor. The question as to whether the material is perfect when delivered to the contractor is not important, as the contractor should take the responsibility if he fails to examine the material at the time it is offered to him.

Mr. Crane illustrates the lack of consideration, on the part of the engineer, for the contractor, by citing a case where pipe which were to be hauled to a certain yard at the contractor's expense were delivered to said yard by the contractor, and then hauled to another yard by a separate contractor. Mr. Crane fails to state that in the case in point the contractor had an excessive price of $10 per ton-mile for hauling pipe. The estimate on which the contract was based called for 100 ton-miles, and without including the hauling which was done by a separate contractor, the amount of work done under this item was 142 ton-miles, or 42 ton-miles in excess of the estimated quantity. The contractor had, therefore, already made all the profit he could reasonably have anticipated on the item, plus 42%, and it certainly would not seem fair to allow him to do work which was not specified in the contract and thereby exceed the contract item by approximately 700% when the contract price was several hundred per cent. in excess of the cost.

On the other hand, it is equally unfair to penalize the contractor by making him furnish material largely in excess of contract quantities, when he has bid one cent per unit and the actual cost is possibly two or three hundred times the price bid. An attempt has been made, in some recent Water Department contracts, to prevent unfairness to either the City or the contractor by not allowing any item to be exceeded by more than 25% without the mutual consent of the contractor and the Commissioner.

In this question, as in all others, there are two or more sides, and Mr. Crane has certainly performed a service to all concerned by presenting the contractor's viewpoint. The City would be the gainer if changes were made in the contracts, eliminating requirements which make it necessary at times, apparently, to be unfair to the contractor, and distributing to each party its share of the burden, fixing, as definitely as possible, the line of division.

MAX BLATT, M. M. E. N. Y.— (by letter).—The paper presented by Mr. Crane is undoubtedly of universal interest to all engineers engaged in City work, and the large attendance at the meeting attests the generally favorable attitude of the City engineers toward suggestions from the contractor's side on the subject of mutual interest, namely, City Contracts and Specifications. A number of points of substantial injustice were emphasized by the author, and while the most important of these lie more properly within the domain of the legal and financial end of our City government, the engineering service of the municipality should, nevertheless, show an active interest in having them corrected.

The contractor's uncertain position in matters pertaining to the property of public service corporations presents especial difficulty, principally legal, in view of the different rights and privileges these corporations enjoy under their charters, and also because of the difficulty of determining by a simple rule, the extent to which the City or its agent, the contractor, is to be permitted to reasonably interfere with the physical operation of these properties. Nevertheless, the effort should be made either by mandatory rule, agreements with the companies, or if necessary by legislation, to relieve the contractor from the costly uncertainty of his position.

The contractor should also know definitely when to expect his payments, or at least when they are due. The Charter provision for a final certificate within five days after the completion of the work, and for payment within 30 days thereafter is almost uniformly impossible of fulfillment, especially on large contract work where the specifications favor payment for every small item of work done, with a consequently lengthy and complex preparation of the final estimate. The time limit for the final payment should be brought more closely to the time of possible fulfillment of this obligation, and some reasonable compensation should, as a matter of simple business, be assured the contractor for any delay in receiving his payment when due.

In the matter also of the estimated quantities, the contractor is left at a decided disadvantage, although in this, as in some other grievances pointed out, the trouble is of his own making. Every engineer, I am sure, is willing to stand by the estimated quantities, guaranteeing their reasonable accuracy. The clause relieving the

City of the responsibility for the correctness of the figures given was probably inserted by the City's legal department as the only effective guard against a multitude of claims for extra compensation or prospective profits based on unimportant variations from the estimated quantities. The proper relief should safeguard the City against trumped-up claims, and should at the same time compel it to shoulder the responsibility for any mistake of its engineers. A provision which would guarantee the accuracy of the engineer's estimate to be such that variations from the figures given on any one item would not increase or decrease the total estimated cost of the contract by more than 3 or 5% would probably accomplish the desired result. This would permit a comparatively greater variation on the smaller and less important items, on which the difficulty of an accurate estimate is greatest.

In the detailed discussions of the spectifications of the various departments the author calls attention to some points on which only an honest difference of opinion can be admitted to exist. Some of the requirements for materials to which the author objects have already been changed in subsequent specifications where experience warranted the modification of the original requirements. On one subject, *i. e.*, the composition of bronze disc rings, a mere clerical error, corrected in a subsequently revised specification, has been used to show the apparent lack of co-operation between the designing engineer and the contractor. I believe that it is safe to say that every progressive engineer in the City's employ seeks both the advice and the co-operation of contractors when writing specifications or planning new work. The difficulty lies in obtaining disinterested, or, rather, impartial advice, and perhaps the greatest task that confronts the designing engineer is to separate suggestions which, if adopted, would benefit all concerned, from the many that are made purely in the interest of one particular contractor or manufacturer.

The phase of the question which seemed to occupy the foreground in the picture of imperfections of City contracts presented by the author, was that in which the personal equation of both the contractor and engineer enters, and from the point of view of the engineer, I cannot let his views go unchallenged. That perfect condition under which the engineer simply designs and lays out the work and specifies the requirements, and the contractor, without supervision or inspection, executes it in exact accordance with the letter and spirit of the specifications, will probably never be reached. Even the author recognizes the need of some agency whose business it is to see that both sides, the contractor and the City, deal fairly with each other. The objection apparently made is against placing upon the human, fallible judg-

ment of the engineer the trust to decide fairly between the two, when that judgment must be combined with the duty to especially safeguard the City's interests. The presumption is, of course, that every clause in the specifications will be reasonably interpreted. Were every contractor as ready to do actual service as he is to do lip service to this rule, the engineer's position as arbiter would be an easy one, and, furthermore, many of the exacting and seemingly objectionable requirements of the specifications would become useless and be naturally eliminated. With slight variation the political truth, "Governments and laws are as good or as bad as the people to whom they are to apply deserve," is applicable to the relationship between the contractor and the City. Many of the clauses in the specifications and contracts are there to counterweigh the inclination of some contractors to take advantage of every loophole, apparent ambiguity and vague description, and some of the so-called "club clauses" found their inception in the refusal of some contractor to abide by the fair judgment of an engineer, interpreting a similar clause more loosely written.

The difficulties existing between the contractor and the City lie deeper than the wording of the specifications. Business ethics, especially in manufacturing lines, have, within the last decade, more and more approached the level of strict business honesty. It is to be regretted that some contractors have remained behind the times, and what is still more unfortunate is that those who have realized that a reputation for good work and honest dealing, even with a municipality, are good business assets—and their proportion is very large—should of necessity be compelled to work under the same rules as those who still cling to the "getting away with it" method. A better purpose would be served if contractors, instead of attacking "the judgment and fairness of the engineer," would direct their energies to ridding their own ranks of its unworthy members. That process is naturally slow and requires also the training or retraining of superintendents, foremen and mechanics in whose unwritten and perhaps unspoken instructions the rule of "any kind of work at the lowest possible cost" must be supplanted by that of "good work at the lowest cost compatible therewith."

On the other hand, no one will defend the engineer whose judgment is biased or who evidences his inability to decide fairly by assuming a generally antagonistic attitude toward the contractor. Coupled with the duty of seeing that the City is actually furnished with the quality and quantity of the work contracted for, is the obligation, recognized by most City engineers, of assisting rather than preventing the contractor to execute the work at the lowest possible cost, and with least possible interference. The engineer must, however, in fairness to the competing contractors, never lose

sight of the necessity of keeping intact and enforcing the conditions and requirements which governed the competition under which the contract was awarded. The substitution of arbitrators or a "Board of Arbitrators," in place of the engineer, has not given satisfactory results, and in the nature of the case, only the largest questions can be submitted to and decided by them. Justice to the contractor often requires decisions to be given immediately, in the field if necessary, and the judgment and fairness of the engineer can be relied upon for impartial interpretation of the written specifications. The contractor's right to appeal to the chief engineer, and in many cases to the Commissioner or other head of the department is an additional and ample safeguard in favor of the contractor against unfair or incompetent treatment by the engineer in actual charge of the work.

A point particularly to be answered is the author's plea for permitting the contractor to "make up," in any way that can be devised, for the possible losses he may have suffered in executing parts of the work. If the particular case quoted by the author, the hauling of surplus pipe, is a fair sample of what he would consider right under this theory, then his proposition becomes astounding. Being familiar with this particular matter I can reduce the proposition to the following: Because of peculiar conditions, the engineer, by the application of a clause of the specifications, could have permitted the contractor to do a large quantity of work, far in excess of the contract quantities and not necessary to complete the contract, at a price twenty-six times its actual value. This would have cost the City $7 100, while the work was actually done under a separate contract for $274. The comparison of the cost if done under the contract and the actual value of the work, together with the fact that the contract quantity on this item had already been exceeded by work actually required, compelled the engineer to decide to have the work done by separate contract. No argument other than the figures given is needed to show that this decision was entirely fair. It is not too much to say that the engineer who might be tempted to subscribe to the "make up" theory advocated by the author, in this or similar cases, would do well to fortify his conception of right and wrong by a careful reading of one of the ten commandments. Certainly, no code of ethics ever accepted or adopted by any body of City or even contractors' engineers would countenance and approve any but the exact decision and course pursued by the engineer in this sample case quoted. The author's other points are surely easier to defend, and are based upon a far higher conception of fair dealing between the City and the contractor.

The relationship between the City and the contractor is a com-

plex one, and Mr. Crane's pleas for the contractor's side is both timely and in many respects well founded. We are especially indebted to him for emphasizing the interdependence of the contractor and engineer, and for reminding us that the best results for all can be obtained by mutual understanding, elimination of antagonism, and the realization that we are jointly interested in and responsible for the proper execution of City work.

Thomas H. Wiggin, M. M. E. N. Y. (by letter).—The author deserves thanks for his clear and temperate criticism of City contracts, which cannot fail to stimulate effort for their improvement.

Most of the criticisms with respect to the Catskill specifications are of provisions which were not gladly incorporated by engineers of the Board of Water Supply. They are without exception criticisms of what we call the contractual provisions as distinguished from the specifications (though the writer does not wish it inferred that attention to the specifications proper would not also be productive of improvement). The process of obtaining an amendment to the contractual provisions is a long one, involving the convincing of many busy engineering and sometimes administrative heads of one's own organization and then the convincing of the Corporation Counsel, who may be so new in office as to be hesitant about departing so soon from the beaten track, or so old in office as to have sad experiences with unjust suits brought under contracts which have not contained the specific provisions in question.

Contracts may be likened to leaky pipes which have been repeatedly caulked with the effect of driving the leaks along to new places. No one but a lawyer who had represented the City in many cases could properly describe or defend, insofar as defence is possible, the requirements that at first reading generally strike a fair-minded man as obviously unfair. And it is proper to state that a good lawyer will frequently trace the history of peculiar common laws and peculiar contract provisions in a way which compels acknowledgment from the layman that the law or provision is less objectionable than the evil it seeks to prevent. The writer made an eleventh hour attempt to get a well-known member of the Corporation Counsel's office to attend the meeting in the hope that a one-sided discussion would be avoided. Mr. Tillson, from his long City experience, was able to bring out the City's side in an illuminating way, and perhaps his written revision will add other facts of interest.

It is, of course, no defence, as the author well contends, that revision is difficult, though it is the reason why revision is necessarily slow, and after all the contractor would rather have the con-

tracts keep coming promptly than have the engineers employ their time in memorializing their superiors and arguing with the Corporation Counsel's office for ideal perfection.

Taking up now a few definite points, the writer splits with the author on his fundamental proposition that contracts may properly be drawn with "club clauses" to protect the City, these clauses to be invoked only in case the contractor misbehaves. A contract should be fair to both sides all the way through and then be enforced impartially. To do otherwise is to increase, in the bidding, the element of gambling on the temperament or rectitude of the engineer, with its train of subsequent sordidness and disappointment. The writer is surprised to hear any other sentiments expressed in connection with the author's otherwise idealistic point of view.

The paving specification forbidding more than $\frac{3}{8}$-in. variation under a 4-ft. straight edge was not a "club" but an honest, and apparently rather successful, attempt to establish a reasonable standard, as Mr. Tillson has explained.

Reference will next be made to the detailed comments on specifications of the Board of Water Supply. The clause following the approximate statement of quantities in the Information for Bidders and words of similar import in Article VIII, disavowing accuracy of estimated quantities, the writer supposes must have at some period pleased the City's legal advisers, since he is sure no engineer would have written so sweeping a statement. Just criticism would be largely satisfied by changes to the effect that, while individual quantities might vary widely, the final total would vary not more than, say, 10 per cent. Court decisions are universally along the line of permitting only reasonable changes in the main quantities, and contractors are not misled by the provision. Large variations, in some cases reaching several hundred per cent., can easily occur in smaller quantities such as water pumped from deep tunnels, underdrains and gravel around them, sheeting and shoring, grout, tunnel and shaft timbering, dry packing, miscellaneous metal work, and reinforcing steel where detailed designs are not made before letting. A case in point is sheet steel in expansion joints of the cut-and-cover aqueduct. At first it was expected such steel would not be used, but to cover possible use a considerable quantity was inserted in the approximate statement of quantities. Repeated tests convinced the engineers of the wisdom of general use of the sheet steel and the quantities are largely over-running.

Such variations in quantity, particularly increases, are a source of great anxiety to the Comptroller's representatives, and each has to be explained to them in writing. The practice exists of giving

generally, in the approximate statement of quantities, figures from 5 to 10 or 12% higher than those computed. A part of this increase is to cover quantities that are too small to compute in detail in the preliminary work, and is legitimate estimating as distinguished from computing. The rest is to cover possible extraordinary and unpredictable increases which otherwise might make the cost over-run the amount of the accepted bid. To the writer's mind this latter object would be accomplished better by setting aside in the appropriation a lump contingent fund than by the general increasing of quantities which occasionally puzzles the contractor in his rough checks of quantities.

The writer presumes the practice arose from the fact that municipal officials have generally tried to hold engineers to preliminary estimates made without a contingent allowance, such officials and legislative bodies being generally unable to realize how impossible it is to give outside limits for each item that enters into that kind of construction which depends on natural conditions encountered. An intelligent contractor knows which items are liable to large errors, and, if he puts in a balanced bid, is not worried whichever way the quantities change, so long as the total is not reduced enough to appreciably affect his overhead allowance. The writer has no sympathy with unbalanced bidding, but agrees with the author that when an unbalanced bid is once accepted the engineer should make all decisions affecting quantities on a usual engineering basis, not lowering himself and his clients to the level of the contractor who indulges in unbalanced bidding.

The clause with respect to omissions (see about Section 7 or 8 in B. W. S. specifications) is as follows:

"The drawings and specifications are intended to be explanatory of each other, but, should any discrepancy appear or any misunderstanding arise as to the import of anything contained in either, the explanation of the engineer shall be final and binding on the contractor. Any correction of errors or omissions in the drawings and specifications may be made by the engineer when such correction is necessary for the proper fulfillment of their intention as construed by him."

In a measure contractors have themselves as a class to blame for such clauses, because they have frequently tried to collect extra pay for work obviously intended to be included, but claimed to be not included because less important things which are just as obvious were covered in detail. The writer has heard of builders used to working under detailed specifications, who would claim the right to put on shingles with one small nail if the exact number and size of nails per shingle was omitted. In such cases the courts generally interpret that the common practice of the

region is intended. The clause under discussion is intended to voice just such a sentiment, and reasonable construction by the engineer must be assumed. If he tries to require paint on a rough board fence where paint was not intended, or to require his steel work to be sand-blasted where such treatment was not specifically stated, or to get a recording gage on his boiler where only "gages" were specified, he is unreasonable and would be defeated by the courts. It will be the contractor's misfortune to have such a man in charge, but if such be in charge, the best specifications conceivable will not help the contractor materially. A rewording of the second sentence as follows would make it satisfactory to the writer: "Any corrections of errors or omissions in the drawings and specifications may be made by the engineer, when such correction is necessary to bring out clearly the intention *which is indicated by a reasonable interpretation of the drawings and specifications as a whole.*" But the most perfect wording cannot eliminate the necessity for honest interpretation by both sides.

The clause making the Chief Engineer absolute arbiter and interpreter was doubtless originally intended as a final waiver by the contractor of the right of appeal to court. In the light of court decisions it can no longer mean that, but it can and does mean that the engineer is to be the judge in the lowest court, as it were, and that questions are to be decided by him and not by tossing a coin or by splitting the difference on every question. It is a truism that there must be a judge in every contract, and, as the author says, no better way has been discovered than making the engineer this judge. He is generally on a salary and has no strong financial bias. His judicial sense and his pride in being thought fair are generally incomparably stronger than his chagrin at being occasionally obliged to acknowledge an oversight in his drawings and specifications. In fact, in larger municipal organizations his active representatives in the field are generally not closely enough responsible for the drawings and specifications to have any strong sense of chagrin at such oversights. These field engineers are quite as likely, from their very closeness of contact with the construction side, to have a full appreciation of the contractor's view point. It must be admitted that the clause has not been refined, as we would probably have done with a free hand, so as to state exactly the bearing it is now generally understood to have. The present wording is as follows:

"ART. 3. To prevent disputes and litigations, the engineer shall in all cases determine the amount, quality, acceptability and fitness of the several kinds of work and materials which are to be paid for under this contract; shall determine all questions in relation to said work and the construction thereof, and shall in all cases

decide every question which may arise relative to the fulfillment of this contract on the part of the contractor. His estimate and decision shall be final and conclusive upon said contractor, and in case any question shall arise between the parties hereto, touching this contract, such estimate and decision shall be a condition precedent to the right of the contractor to receive any money under this contract."

The writer would alter it about thus:

"ART. III. To prevent disputes, the engineer shall in all cases determine the amount, quality, acceptability and fitness of the several kinds of work and materials which are to be paid for under this contract, and shall in all cases decide every question which may arise relative to the fulfillment of this contract, *subject to the contractor's right of appeal to the courts;* his estimate and decision shall be a condition precedent to *and conclusive of* the right of the contractor to receive any money under this contract."

It will be noted that the writer's alterations tend to more clearly endow the engineer with judicial powers, his decisions controlling the City as well as the contractor. It is a delicate question how far the engineer's actions may be reviewed by a board or commission. The Board of Water Supply contracts in the first article have this clause: "Wherever in the specifications or upon the drawings the words directed, required, permitted, ordered, designated, prescribed, or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation or prescription of the engineer is intended, and similarly the words approved, acceptable, satisfactory, or words of like import, shall mean approved by, or acceptable, or satisfactory to the engineer, subject in each case to the final determination of the Board, unless otherwise expressly stated."

Article III, above discussed, does not expressly deny the reviewing power of the Board, but the engineer's knowledge of materials and construction would seem to make his supremacy under Art. III during his incumbency a natural interpretation.

The author's suggestion for one arbiter appointed by an impartial body has merit, but the writer doubts if any provision could generally thwart the lawyers for the losing side in getting the case before the courts. This and other reasons may be urged in favor of going at once to the courts. It is to be regretted that there are so many chances for appeal from lower to higher courts. The most discouraging thing in this connection is the deliberate intention and systematic preparation of many contractors to add profits or recoup losses by lawsuits in which claims admitted afterwards to contain 90 to 95% water are stoutly advanced. Reputable firms often obtain much perjured gain, particularly after the engineering force that know the facts has been scattered to the four

corners of the earth. Engineers in charge of large works for New York City have almost invariably had an enviable reputation for fairness, yet in probably less than half of these large City contracts does the contractor accept, without appeal to the courts, the carefully adjusted estimates of these engineers. It is safe to say that all of these estimates do more than technical justice, *i. e.*, contain substantial compromises made in part to avoid suits, but many contractors simply use these compromises as a stepping stone in their grasp for more. They seldom admit a profit and yet one sees in their lives constant signs of prosperity. The Contractors' Association, of which the author is secretary, would do a great work if it could engender a healthy sentiment among its members against unjust appeals to the courts and presentation of padded claims. The City can better afford to receive higher bids than to suffer such subsequent pilfering, which unsettles good faith, congests the courts and wastes so much labor in trials and in preparation therefor. The writer is aware that courage, in the face of criticism by the sensational press and by zealous officials, in the rejection of low bids when made by unworthy bidders or too low to permit a living profit, would reduce the temptation to bid below reasonable prices to get work in the hope of recouping by lawsuits or concessions.

The clause providing that work may be suspended without compensation and with only a time extension, is manifestly unfair, and modifications have often been suggested. A certain amount of delay in various parts of the work is unavoidable and should be covered by the contingent allowance. The author's suggestion of a liquidated damage agreement is good, *provided the details can be worked out.* For a stopping of the whole work no difficulty in accounting would be experienced, but most delays are of only a part of the work, and occasional small delays should not be counted, otherwise too much temptation would exist to conduct the work so as to fatten this item rather than maintain progress.

The author's comments on the unjustness of making the contractor in the Board of Water Supply work solely responsible for the safe conduct of the work and then permitting the engineer to prescribe methods is not well grounded, in the writer's opinion. The whole tenor of the Board of Water Supply specifications is to permit the engineer to *increase* the factor of safety in temporary works, but not to decrease it. This right is only exercised in flagrant cases and it would be unfair to assume that the engineer is thoroughly satisfied with all the contractor's provisions which he doesn't order changed. The contractor is given a very free hand and should bear the responsibility. The engineer has not time to check all the contractor's plans and generally knows only what he

can judge from casual examination of the temporary works as they are erected. A pertinent sidelight on this question is given by the following standard Board of Water Supply specifications drawn by the writer:

"SECT. 50. The contractor shall notify the engineer in writing before beginning or ending any type of supported tunnel, or, in case of emergency, as soon thereafter as possible. He shall indicate the type chosen, fully describing sizes and spacing of members and any proposed modifications of the contract drawings. The engineer may order more frequent spacing or larger members, if, in his judgment, the safety or ultimate speed of the work requires such change, but in this case the contractor must take full responsibility for the sufficiency of the support, and shall be in no measure relieved therefrom by the failure of the engineer to order increased strength. The engineer may, furthermore, order the use of smaller sizes or larger spacing, or the adoption of a different type from that proposed by the contractor. If the contractor shall be of the opinion, and shall so certify in writing, that he regards the support ordered as unsafe, the engineer may still order the work done, and the contractor shall be relieved from responsibility for the success, but not for the energetic prosecution of the work. The repair of any settlement or failure due to the use of the engineer's method shall be paid for under appropriate items."

The clause relating to the removal of sub-surface structures is a lame member, as the author states. This is due to the knowledge of City officials that the City cannot, as constituted, act vigorously and promptly in asserting its rights. The Board of Water Supply specifications permit the contractor to remove property of delinquent corporations, but do not tell him who to collect from. The writer was responsible for not incorporating in the Board of Water Supply specifications the old provision of inviting the contractor to collect from the corporations. It was so obviously inequitable, since the City is the only one with right to sue. If the first and precedent-establishing contract containing work in City streets had not been in a hurry (to accommodate the paving department), the writer would have recommended adding that the City would pay any duly audited bill of the contractor for doing work properly belonging to corporations. The writer was of the opinion that omitting this addition did not lessen the City's obligation to pay such bills.

The writer would like to discuss the other points in the paper, but has already taken more than his share of space, and will conclude, somewhat as he began, with a comment on the desirability of having good specifications and sticking to them. The writer's repetition of this sentiment is due to the author's repetition of the idea in the words:

"Some engineers are too narrow to realize that a specification is a *standard*, and that an approximation to that standard fulfills

the contract. The man who rejects masonry because the joints deviate a fraction from the specification, or piles because they are a half-inch under size at the butt, doesn't appreciate that he is standing in his own light. He never becomes a big engineer; he never has *time to learn engineering,* he is too busy inspecting."

It is, of course, desirable to give the engineer latitude to meet unusual conditions, and this the Board of Water Supply specifications attempt. Sometimes they resort to the words "unless otherwise permitted" to save long explanations of conceivable situations requiring change from the general rule. In the early drafts of B. W. S. specifications the writer attempted to elaborate such exceptions instead of using the expression "unless otherwise permitted," but it was decided not to add so many words in an attempt to predict the almost unpredictable. The careful engineer hates to be put in the position of permitting a direct violation of the terms of a specification. He feels as if he were stulifying himself, unless the violation very clearly causes an improvement to the work, which is not the unusual case, as improvements generally cost money and the contractor constantly presses for the acceptance of cheaper processes. There is too much tendency, the writer thinks, for the contractor to urge and the engineer to accede to such changes. The engineer is human and would much rather say yes than no, particularly to a good contractor who has too low prices. But such tendencies are in the long run demoralizing to both engineers and contractors, since they unsettle standards of both honesty and workmanship and increase the gambling element in bidding.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 68.

PRESENTED NOVEMBER 22D, 1911.

THE PORT OF NEW YORK.

BY CALVIN TOMKINS.*

WITH DISCUSSION BY

DANIEL L. TURNER AND SIDNEY W. HOAG, JR.

Gentlemen of the Municipal Engineers: It affords me great pleasure to be with you this evening. I am sorry I have not been able to prepare a written address. I have a few head notes which I shall talk from, skipping from point to point as rapidly as possible, so that we may reach the lantern slides which illustrate my remarks perhaps more effectively than anything I can say. The Engineers of the department are here who will help me if I am unable to answer and we should like to have any suggestions that you have to make.

First, the relation of the Port of New York to the commerce of North America and Europe.

The Port of New York is the greatest seaport in the world, as well as the greatest port and city in North America. London is the only city that exceeds it in size and population. Its importance is due to its geographical position, that is, its magnificent harbor and the easy line of approach through the Hudson and Mohawk Valleys, by way of the Great Lakes to the Mississippi Valley. This is the cheapest route to the sea and controls all rates east of the Rocky Mountains. It determines whether traffic shall move from Chicago east to the Atlantic Ocean, or whether it

* Commissioner, Department of Docks and Ferries, New York City.

shall go to New Orleans or Montreal. The low cost to New York is the influence that makes rates to other ports.

In past years, before the days of railroad regulation, competition was so extreme that in order to avoid disastrous rate wars, a differential was imposed upon New York's commerce in favor of Boston, Baltimore and Philadelphia to the extent of three cents a hundred pounds. This occurred in 1882, I think, and it has remained ever since, although there is no longer danger of railroad rate wars, and although steamship rates to New York are now no cheaper than to other seaport cities. In addition, the general railroad rate of the country has gone down, so that this fixed arbitrary differential is a larger proportion to the freight rate now, than it was when originally imposed.

Until recently, the Interstate Commerce Commission has had no power to fix rates; now they have. They are also charged with the responsibility of not discriminating between ports, and it is reasonable to suppose that the petition which is now pending before them, asking for relief from this differential, will be decided in favor of the City and a great impetus given to its trade as a consequence.

I mention the differential to show how the other ports, and railroads terminating at them, endeavored to safeguard themselves against the natural conditions with which New York was favored and which they could not meet.

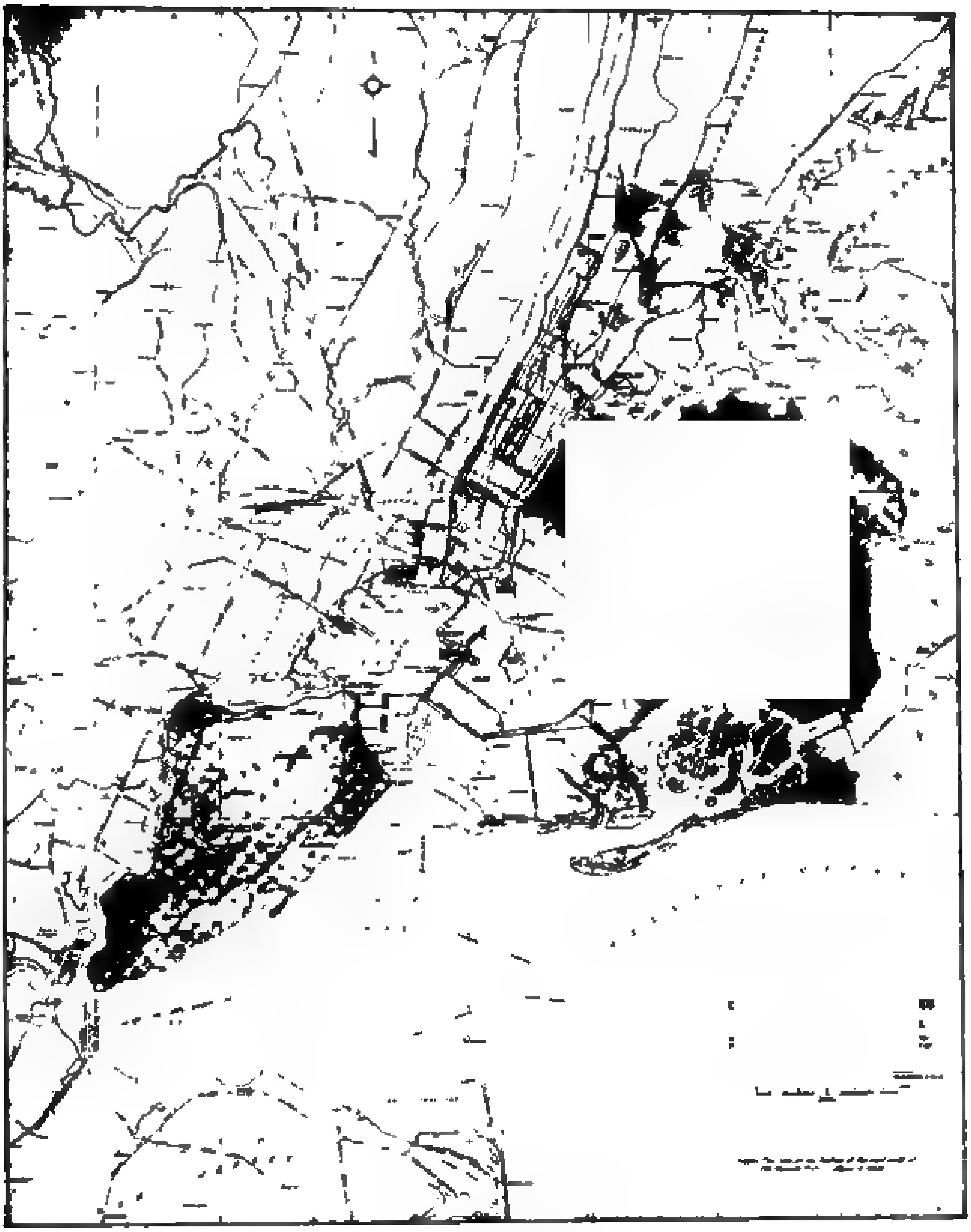
This cheap route to the sea, and the wonderful facilities of New York Harbor, have placed our City in this enviable position. On the opening of the Panama Canal, a new era will be entered upon, and New York will become not only the great port of North America and the greatest seaport of the world, but it will become *the* seaport of the world, that is, the meeting place of the commerce of the east and west sides of North and South America and the Orient with the commerce of Europe. New York will become the great transhipment point of occidental and oriental trade. During the middle ages, Venice occupied such a position as the point of exchange between the East and West. On the discovery of the Cape of Good Hope the supremacy went to Amsterdam for many years, and then it passed to London. Those three ports, in turn, each occupied the position of dominating the world's commerce. Since

London has declined from that position, as the consequence of the development of Liverpool, Antwerp, Hamburg and Rotterdam, there has been no distinctive world port, but we are about to enter upon a period in New York's history when our responsibility to the world's commerce will be comparable to the responsibility of these three great seaport cities.

The difficulties of preparing for the situation are very great. First, we have neglected the matter for many years. Then, the natural features of the harbor are on such a gigantic scale, that they cannot easily be adapted, as is the case in most seaports of the world. The great tidal estuaries which separate the harbor into four parts,—the New Jersey district on the west, the Long Island district on the east, Manhattan and the Bronx in the middle and Staten Island on the south,—prevent proper organization, and we cannot expect to have the harbor properly organized until car transportation and lighters and ferry-boats give way to tunnels which will tie the several parts of the harbor together as they should be. We already have passenger tunnels under the harbor waters. It is only a step farther to the freight tunnels. When that comes, we will be in a position to properly organize the port. Whatever we do in the meantime is a make-shift, but whatever is done should be done with a view to this more comprehensive organization later on. Again, the harbor is situated in two States, New Jersey and New York. The railroad terminals of the country for the most part are in New Jersey, and the jurisdictions of both States make it hard to reconcile interests and provide that unity of plan and organization which is the fundamental requisite of seaport development.

Until recently, this great amount of space about the harbor, where anybody could come and do almost anything he liked, either a railroad or a private manufacturing concern,—this spaciousness about the harbor and its shores,—has made it unnecessary to consider the questions of organization, and we have not given the attention to them we should. I believe the fundamental reason why New York has not already developed a port policy and a plan to be progressively carried out, like Hamburg and Antwerp, and Manchester and Rotterdam have done, is simply because the matter has not been forced upon the attention of the citizens and the com-

PLATE 63.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
TOMKINS ON THE PORT
OF NEW YORK.



Map of the Waterfront of the City of New York, showing Contemplated Improvements for Railroad Terminals and Waterfront Development, including the Proposed Improvement of Jamaica Bay.

munity. At the present time there is congestion only at one locality on the west side of Manhattan. There is plenty of room around the harbor elsewhere. The impression has been circulated in the papers that we are badly congested in New York harbor, and the discussion we have had regarding congestion in one spot is responsible for this impression. The fact of the assemblage of the enormous naval fleet here two weeks ago, is sufficient refutation of the statement that New York harbor is not able to provide for its commerce. No such display could take place at any other port.

Experience has demonstrated at the great ports of the world the applicability of certain general principles. In the Dock Department we are not advocating anything new. The engineers and commissioners have ascertained certain things to be necessary as a result of simply visiting other ports. Of course, we have had to adapt information which has come to us to our special needs, but the main points of organization are common to all seaports. Briefly stated, they may be summarized as follows: That each part of the port should be planned for its best natural uses, and that all should be tied together by railroads, so that all parts of the port are accessible to all railroads. When the physical organization shall have taken place, there must also be unity of administration, and that control must, of necessity, be public. The private control of the harbor by railroad and steamship companies must certainly give way to public control. Some ports of America have already adopted this principle. Montreal has done so and the Dominion of Canada runs the locomotives on a marginal way that ties up the waterfront. The transfers are made by an Administrative Commission, which conducts the port down to the smallest details. San Francisco is operating a marginal railroad and so is New Orleans.

We do not think, in the Dock Department, that there should be any attempt to force upon the City the actual operation of the waterfront utilities. We do think the City should administrate the docks and they should control effectively the lands back of the docks for warehouses and railroad enterprises, and impose such a plan upon these back lands so as to connect all possible factory sites and make them accessible by railroad switches. In short, gentlemen, the organization of the Port of New York is tantamount to a reorganization of the railway terminals at the port, and the

spirit of individualistic control, with the purpose of competing at the terminals, is so strong with the railways, that it is the principal obstacle we have to overcome. In my judgment, it is not the physical obstacles which are so serious as it is the disinclination of one railroad to co-operate with other railroads or with the City. Mr. James J. Hill said that the weak point of the railway system in the United States is the terminals in the large cities. The enormous increase of land values in the cities, the difficulty of changing the City plan and the inclination of the railways to individualistic control of terminals for the express purpose of competing, make the situation difficult. All the competition that is left to the railways is competition at the terminals and, I believe, ulimately and before very long, the terminal charges will be separated from the freight rate.

If you examine the conduct of the terminal routes at other seaports, principally in Europe, you will find that the joint use of common terminals under public control, is universal, and it has already begun in America. Those cities which adopt that policy first are the ones which will grow at the expense of those which are not so alert.

Port development is not a new science, although it is in its infancy at New York. Our great foreign rivals, such as Hamburg, Antwerp and Manchester, as well as Montreal, New Orleans, San Francisco on this side, and a rapidly increasing number of other ports, have definitely abandoned the nineteenth century stage in which we still remain, and have worked out plans, a mere glance at which shows that we must either copy or better them, or surrender New York's pre-eminence. The basic principle on which they have proceeded is that a port must be developed as a unit, and under public dictation of the terms on which private carriers, shippers and consignees shall be served. The port being once conceived as an organic whole—administered by the City for the benefit of all—there can be no thought of remaining in or returning to the chaos of jarring private rivalry and mutual obstruction from which we suffer, or of final dependence on the makeshift policy of separate sub-ports constructed by great private corporations, no matter how perfect each may be in itself or how welcome they may be as co-operators in a City system.

Fig. 1.—Showing Typical Congestion of Marginal Way along the North River Waterfront.

Fig. 2.—Showing Typical Congestion of Freight in Interior of Pier 27, North River, with Resulting Narrow Trucking Space.

FIG 1.—SHOWING COMPLETE CONGESTION OF SLIP BETWEEN PIERS 27 AND 28, NORTH RIVER, BY CAR FLOATS.

FIG. 2—SHOWING CAR FLOATS AT COMMUNIPAW LOADED FOR TRANSFER TO MANHATTAN.

At every seaport there are two great uses to which the waterfront is put. First, commercial; second, industrial. Some seaports have very little industrial development. Antwerp has little. New York, London, and Manchester are enormous manufacturing centers, as well as commercial transhipment points, and it is of far greater importance to a community to have industrial development than to be noted simply for the commerce which flows through it and which it exchanges with the outside world. Factories mean population and wealth which they draw in their trail, while commerce means simply commodities passing through the port, involving the activities of a few longshoremen, and some increase of banking power. Industry means a great deal more than that. The development, as far as possible, of every factory site by railroad connections, available for all the railways and accessible to all the steamships is the great thing to secure.

New York pre-eminently retains, and always will retain, the commerce of North America. Some little overflow will go to Philadelphia and a larger amount to Boston, and Montreal will take care of the food products of Canada for much of the year, but the great export and import business of North America will always be conducted from New York. The ocean ferries are now centered here. New York is the focus of all the railways of North America. Those that do not come here actually with their rails, do so by their coastwise steamship connections. All focus here for the purpose of taking advantage of this system of ocean ferries radiating from New York to all ports of the world. London, at one time, enjoyed that pre-eminence. New York enjoys it now and it will be immeasurably added to by the Panama Canal as soon as it shall have been completed.

The competition between ports forces the municipal organization of the waterfront. This competition is the sharpest in the world, and forces each port to adopt the most up-to-date facilities and to administer its transhipment business in the most effective way possible or to lose its commerce to other ports that are more enterprising. There is no room for private profit on the waterfront; to handle traffic in the cheapest way, private profit must be excluded and that is done by municipalization. That has been carried out in Manhattan. A beginning has been made at South

Brooklyn and Staten Island and elsewhere, and nothing is more certain than that the municipalization of the waterfront will steadily and progressively go on. It brings up a nice question of adjustment between public and private interests. If the process goes on too fast, the City treasury will suffer and private enterprise will be put to undue competition with it. In South Brooklyn, where the process is just beginning, the Bush Terminal and the New York Dock Company are only too anxious that the City shall take over their waterfront properties, leaving them their warehouses and factory business and the railroading in the rear, and they are willing to submit to control over these functions.

Another thing is quite certain, that the improvements on the waterfront will not be paid for out of tax receipts. If we rely on that source of income for improvements, they will come too slowly. The waterfront improvements must be made to pay for themselves, and they can pay for themselves, as is illustrated by the enormous dock fund now on hand. The Comptroller estimates that fund at the present time to be $73 000 000, and it is available for dock improvements or for subway improvements. We think that should be utilized for dock improvements which afford the basis on which the prosperity and continued growth of these great communities around the harbor waters depend.

It is necessary that, as we spend this dock fund for improvements, we should keep these improvements in the self-sustaining class of investments, so that they will not be included in the debt limit and so that they may be progressively released from the debt limit, realizing a similar amount of money to be spent for further improvements. Otherwise the dock development will be discontinued. Hamburg, Rotterdam, Manchester and Antwerp have carried out enormous improvements, aggregating hundreds of millions of dollars, which for these cities is far in excess of similar sums for New York, and they have done it in this way.

It is very desirable that the City should plan in advance for its waterfront uses, otherwise there is likely to be conflict of plans and what is done will have to be undone in the future.

One characteristic of suburban development along the waterfront, is to get much of the manufacturing out of the City into the suburbs, where land is cheaper. We cannot control city growth

PLATE 66.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
TOMKINS ON THE PORT
OF NEW YORK.

Two Recently Constructed Piers, Over 1,600 ft. Long, in Gowanus Bay, South Brooklyn, 31st and 33d Streets.

as they do in Germany. We must plan conditions under which it will be desirable for industries to settle in certain locations and residents in another.

Manhattan is pre-eminently the landing place for passengers and the landing and shipping point for package freight of the highest class. If the large steamships are not able to dock at Manhattan, and the passengers do not come to this central borough where they want to come, New York is likely to lose a considerable portion of its passenger business, which is the most valuable asset that the City has. Of that rich traffic, the richest in the world, almost all of it passes in and out of the harbor of New York, and if it comes to Manhattan, most of the people remain in the City and spend their money, and it means a great deal to the shops and hotels, etc., and the City will certainly suffer if that traffic is shunted off to New Jersey or to South Brooklyn or some other part. I have no fear that we will lose most of it to Boston or Montreal. I think Montauk is something we need not be frightened about in the present. Perhaps in another generation it will loom up as a port, but it is desirable that the passenger business be conducted and retained in Manhattan.

The great freight terminal of the port for deep-water ships is at South Brooklyn, between the Pennsylvania Terminal at Bay Ridge and Atlantic Basin. The Bush Terminal is admirably organized. It is the one great modern port example on this side of the water. It is the best organized terminal in the world, except for the mechanical handling of commodities. They do not take advantage of mechanical devices for unloading, as they do in Europe, but in the organization of the dock front, it is the best organized part of the port and the best organization that exists in this country.

In the Bronx, little has been done as yet. There is no opportunity on the Harlem River for great development. A few railroad terminals will be located there, and they can be increased on the Sound between Hunts Point and the Bronx River. Between the Bronx and Hudson Rivers there is a great opportunity for industrial development, which can be taken in hand. The New Haven Railway system and the New York Central system can be connected with it in such a way as to most admirably serve its industrial de-

STREET FRONT OF RECENTLY CONSTRUCTED CHELSEA SECTION STEAMSHIP TERMINAL, BETWEEN GANSEVOORT MARKET AND WEST 23RD STREET.

have become a dangerous nuisance, the necessity for longer piers to accommodate the ocean steamships of the first class, and the expensive congestion which freight is subjected to, part of which is borne by the railroads and a very much larger amount borne by the merchants of the City in delays in getting their goods to the terminals, are factors which are making a prompt solution necessary. Then, again, there are another set of forces at work which are forcing our attention in this matter,—the great responsibilities that are coming to us as the result of the completion of the Panama Canal, and the Erie Canal with its terminals, and the modification of the differential freight rates against the City of New York are placing responsibilities on our shoulders which we are beginning to feel now and which we must meet, otherwise we shall be swamped with the business which will crowd us in the near future.

To meet this growing situation we have done very little actual work during this present administration. I believe the Dock Department has done less in construction as embodied in new work, than any other department in the City of New York. We have nothing to show, except the plans we have made for the future and the upkeep of the public property of the City which is placed under our charge. We have used the opportunity to prepare our plans and the engineers of the department and the Commissioners of the department have begun to see the way out. We have published our plans for the west side of Manhattan, and plans for South Brooklyn; plans for Staten Island are ready and we know what we are to do in the Bronx and for Queens as well, and now it is incumbent upon the City to carry them out. Some of the plans are before a committee of the Board of Estimate and Apportionment, and the responsibility is with them.

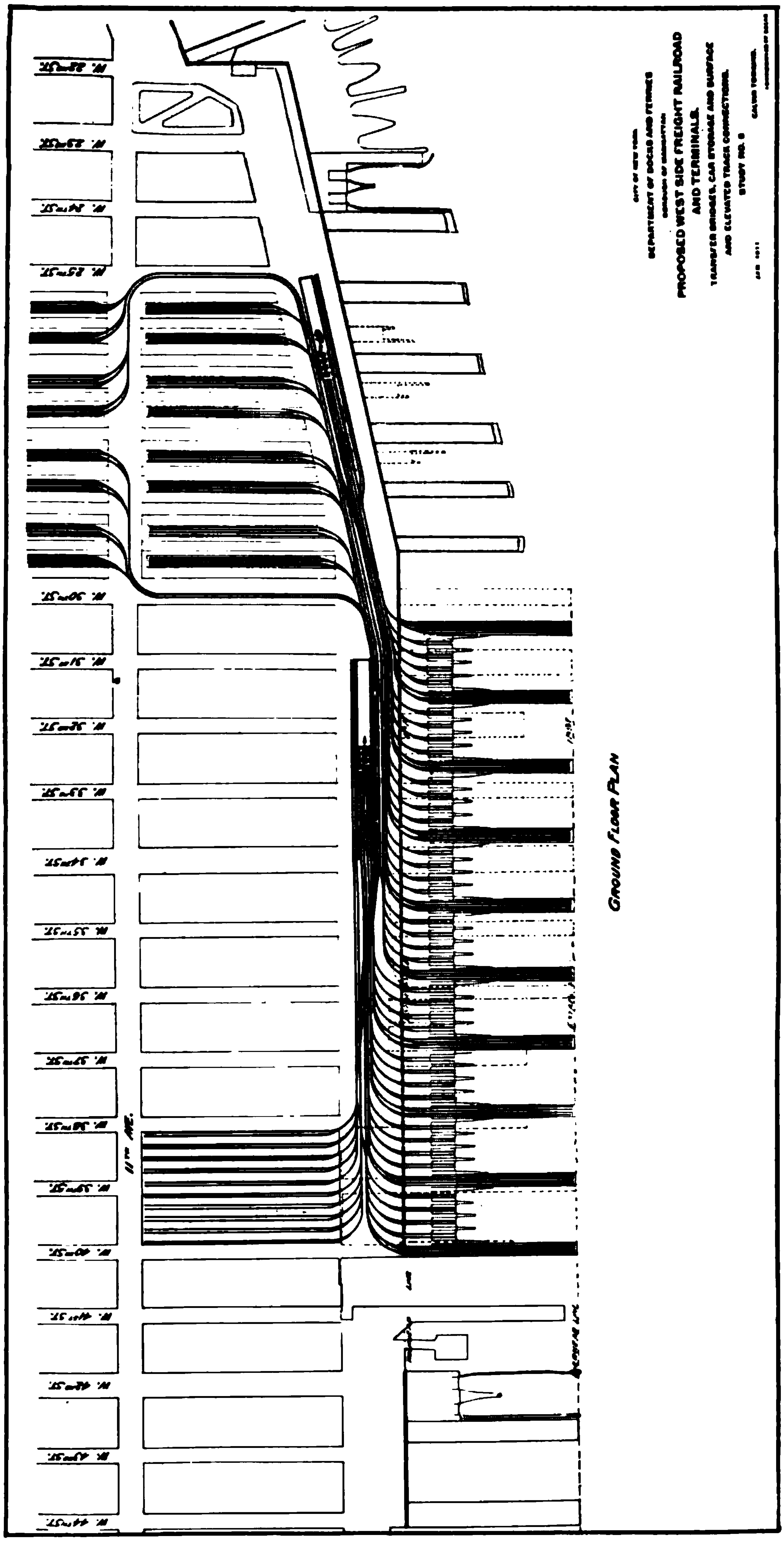
Then the City has the funds to go on with. Finally, the City has power. In the face of the most bitter opposition, the Dock Department and the Mayor of the City secured legislation embodied in three laws, which gives the Port of New York more complete power than any city in North America enjoys. There is no excuse for not proceeding for lack of power. As regards docks, we have complete home rule. We not only can take property for public use, but we can take the land back of it and lease it. We

can construct the warehouses and railroads; we can operate the warehouses and operate the railroads. We do not expect to do so, but we have that power. The City has the power to delegate these powers to private terminal companies as distinguished from railroad companies and to authorize them to proceed in accordance with the law to organize the waterfront and so avail of their capital and experience to expedite development. The City has the power to give to the New York Central, as a monopoly, the entire west side of Manhattan for its own use, or it can reserve complete control of the New York Central developments and retain part for general railroad uses. There is no longer excuse for lack of funds, lack of power, or lack of plan and policy.

The commerce of the City is beginning to suffer as the result of high terminal charges, and the situation cannot go on much longer before we begin to feel it in our pockets. Commerce and industries are being deflected to Boston, Baltimore, and Philadelphia, through protracted delay on the part of the City of New York.

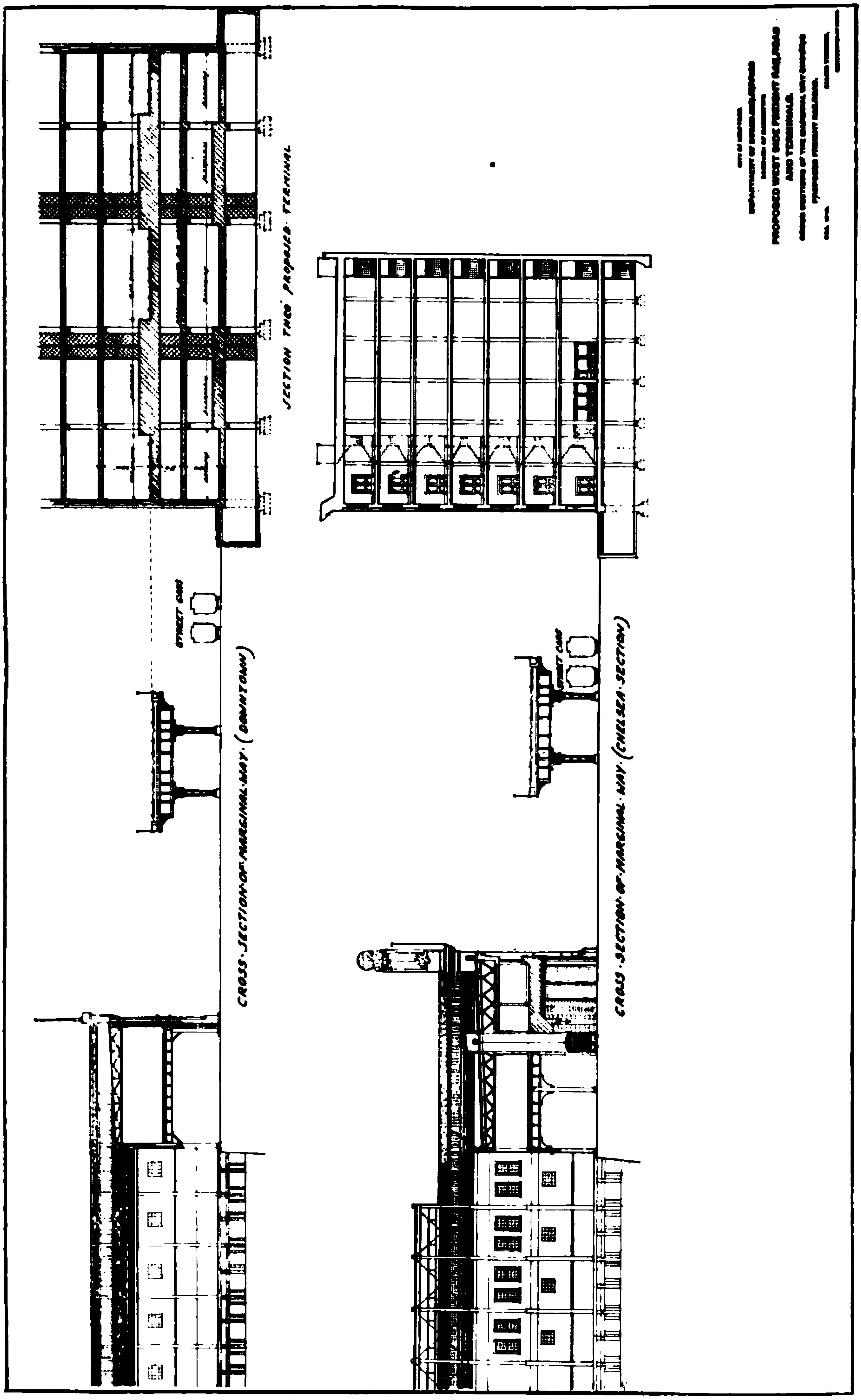
The port problem of New York is not a local one at all. It is national and international in its significance, and if the City of New York does not meet its terminal responsibilities, nothing is more certain than that the administration of the port will be taken away from the City, either by the State or by the Federal Government, and that, I believe, will be unfortunate. I do not believe this will result; I believe the City will rise to its responsibilities. Here we come to the weak spot in our municipal organization. We cannot depend on experts in American cities for organization and development as they do in Europe. The time will come when we shall do so. The power and influence of your own organization, which has been growing in recent years, is sufficient proof of that fact. But we do not do so now and we will not for many years to come. The politician and the business man who do not know from actual experience the needs of the City, are the men who will have control of the City, and the only safeguard against their ignorance is the creation of a sound public opinion regarding public improvements which shall overcome the difficulties incident to changing administrations. We can have continuity of plan and policy only if we secure public sentiment, and I believe your organization can do much in building up that opinion. The technical man in

PLATE 69.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
TOMKINS ON THE PORT
OF NEW YORK.



Proposed Transfer Bridge Terminal for Use in Connection with the Proposed West Side Freight Elevated Railroad.

PLATE 70.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
TOMKINS ON THE PORT
OF NEW YORK.



TYPICAL CROSS SECTION SHOWING FREIGHT ELEVATED RAILROAD—BULKHEAD AND PIER BUILDINGS ON THE LEFT, AND WAREHOUSE DEVELOPMENT ON THE RIGHT.

the management of city affairs is vital and as Commissioners, and as public men, we depend upon you for support in fixing upon the City a continuity of plan and policy as regards not only the waterfront development, but all the other public improvements in the City.

I would say that in developing these plans to which I have referred briefly, the Dock Department has sought all the criticism it could get. Our plans have been put forth at first as tentative plans. They have been sent to people who we thought would be in opposition. We have endeavored to secure newspaper criticism; we have gone so far as to write the criticism ourselves, to draw out the opinions. The difficulty is to obtain public discussion in the press that we would like to have and that we should have. It is not news in the sensational sense; it is a commercial problem more so than an engineering problem, and the papers do not notice it. Such criticisms as have been directed against the Department's plans have appeared very much more freely in papers outside of New York than in New York. It is no reflection upon our New York papers, it is a reflection on the readers. They do not seem to be interested in such news, but they are giving more attention to these matters from month to month, and, I believe, that as the West Side matter and the South Brooklyn matter progress, public interest will rapidly develop.

I thank you very much for this opportunity to speak to you.

DISCUSSION.

Daniel L. Turner, M. M. E. N. Y.—I observed, in the sketch showing the marginal railroad, that it was shown in the center of the marginal way. Was the project of constructing that road contiguous to the pier heads considered, and, if so, why was it discarded? Would not the pier-head railroad permit the space underneath the road to be used for pier-head sheds? Such a railroad could be very easily connected with the piers for mechanical handling of the freight, if contiguous to the pier. I do not mean to run tracks on the piers longitudinally; I simply mean going along the pier head. I mean that if the railroad were contiguous to the pier, a very convenient transfer of freight could be arranged between the railroads and the water carriers.

Sidney W. Hoag, Jr., M. M. E. N. Y.—Mr. President: In response to Mr. Turner's question as to why the proposed elevated railroad is not carried along the bulkhead rather than down through the centre of West Street, I would like to say that the conditions controlling the location as tentatively proposed are track grade, overhead clearance, facility for turning out and division of street traffic. It is necessary, for economy in construction, to keep the railroad at as low a grade as possible consistent with sufficient headroom or clearance for street traffic, maintaining at the same time a minimum length of ramp approach consistent with minimum gradient of ramp.

Again, this grade must conform with the necessary requirements for second-story approach to warehouses, as it is intended to run the trains from car-floats up a ramp onto the elevated structure, and thence downtown to the different terminal warehouses, where the trains will turn out and enter the warehouses in the second story. This minimum grade of car track prohibits any combination between elevated railroad structure and bulkhead shed buildings, and for this reason alone it would be necessary to carry the elevated structure outside of or inshore of the bulkhead shed area.

In order to turn out from the main tracks into terminal warehouses located along the easterly line of West Street, and at the same time leave it practicable for making possible future turnouts onto piers, it is quite necessary to locate the line in the center of the marginal way. Again, such a location creates a logical longitudinal barrier forcing a division of the street traffic into northbound and southbound.

As a matter of fact, it is not proposed to locate the elevated road in the center of West Street, as West Street is only a 70-ft. street comprising the easterly 70 ft. of the entire marginal way, which is really 250 ft. wide, less the strip 50 ft. in width occupied by the bulkhead sheds.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.

Paper No. 69.
PRESENTED DECEMBER 27TH, 1911.

SOME OBSERVATIONS IN REGARD TO WATER-WORKS PUMPING STATIONS.

BY NICHOLAS S. HILL, JR.,* M. M. E. N. Y.

WITH DISCUSSION BY KENNETH ALLEN.

One of the salient characteristics of the average water-works plant is a very apparent lack of steam engineering knowledge as exhibited in the design of pumping stations.

In fact it may be said, without prejudice, that the mechanical details of filtration plants and of other elements of water distribution requiring skill in mechanical engineering are, in many instances, poorly or carelessly executed. This observation suggests the thought that possibly in the modern development of water plants the civil engineering and sanitary problems have been given such great consideration that the mechanical details have been overlooked or, at least, carelessly devised. (See Plate 71, Fig. 1.)

The pumping engines themselves have undergone steady development and improvement until at this date the pumping engine is a most efficient machine. Improvements in design, with the decided tendency to reduce the number of working parts, have been constantly made, with resultant economy in cost of operation and maintenance. The builders of pumping machinery have abandoned former ideas of special design. The fact that a pumping engine differs from other engines only in the application of its power directly to the pump plunger in place of the shaft of a dynamo, a propeller shaft, or belt wheel, is realized as never before.

* Consulting Engineer, 100 William St., New York City

The comments just made in regard to pumping stations are, therefore, not directed at the pumping machinery. In fact, the majority of engines purchased to-day are furnished by responsible companies, and the knowledge of their duty performances under given conditions is quite general, so the pumping unit, considered singly, is economical and efficient. The departure in pumping stations from the best practice in modern power stations must be looked for in the selection of the type of engine to be installed, in the boiler plant, the general arrangement of machinery, steam piping details, the utilization of waste heat, and the efficient disposition of auxiliaries. All of these elements enter into the *station* duty, which is the final and economic measure of the operation of the plant.

Trial Duty Performance of Steam-Driven Condensing Pumping Engines.

(1 000 pounds dry steam.)

Vertical, Triple Expansion, Crank and Fly Wheel..	140	to	180
Horizontal, Cross Compound, Crank and Fly Wheel.	110	"	140
Horizontal, Duplex, Direct-Acting, Triple.........	75	"	110
Horizontal, Duplex, Direct-Acting, Compound.....	50	"	70
Turbine-Driven, Centrifugal Pumps..............	70	"	90
Engine-Driven, Centrifugal Pumps...............	70	"	90

Many engineers place too much value upon the trial engine duty. Engine duty represents only the efficiency of the engine. This is one of the very important items embraced in the cost of pumping. The effectiveness of the remainder of the plant is of equal consequence.

An engine may develop a high duty and be economical as a unit in the consumption of coal, while the station duty is relatively low. The total cost of pumping may be high, though the station duty is excellent and the cost of pumping based on pumping station expense is low, as a result of using costly engines of high efficiency when not warranted and thereby unduly increasing fixed cost. Sight must not be lost of the fact that the cost of coal, which is the item chiefly affected by high engine duties, is, in most cases, but 30 to 45% of the total operating cost and a much lower per cent. of the entire cost of pumping. It is obvious therefore that conclusions based on operating expense only may be misleading.

Duty is the measure of efficiency usually used in considering pumping plants or pumping machinery, and it is the ratio of work done to the energy expended in doing it. The terms generally employed at present are foot-pounds duty per 1 000 lb. of steam or per 1 000 000 heat units. Formerly it was used on foot-pounds per 100 lb. of coal. If the last named basis is used, the plant efficiency is also included and it may be correctly termed the station duty. It embraces boilers, steam pipes, feed pumps, heaters, etc., which have not necessarily any relation to the individual efficiency of the pump. It is the commercial test to be used in daily operation. It expresses the efficiency of the plant as a whole.

A word with relation to the all too common practice of requiring the builders of pumping machinery to bid upon a complete plant or to furnish machinery not fabricated by them. This practice, which is to be deplored, is not in accordance with custom in the erection of other power plants.

The builders of pumping machines should only be required to erect the engines, complete with condensers and attached auxiliaries, if used, on foundations supplied by the purchaser. If, however, he is called upon to furnish other machinery, he should be made responsible for the efficiency of the entire plant in order to stimulate the same attention to details and the proper design of the boiler plant, piping and other equipment, as is given to the engine. Under these conditions the contractor should be made to guarantee station duty as well as engine duty.

It is much better to divide the work and to let contracts so that the buildings and foundations, stack, engines, boilers, piping, economizers, and other machinery are obtained from contractors especially equipped in their various lines, or else that the contract be given as a whole to a general contractor who will sublet the respective parts, and obtain the necessary guarantees from each sub-contractor.

In the event that the work is properly divided, the engine builder should guarantee only the efficiency of the pumps, condensers and auxiliaries, and the duty required for the engine test should be expressed in terms of steam or heat units, in accordance with the rules formulated and approved by the American Society of Mechanical Engineers.

The boilers, economizers, heaters, and other machinery installed should be in accordance with specifications prepared by a competent engineer and a proper guarantee of efficiency should be made by their manufacturers, and these elements should be tested independently to determine whether the guarantees are fulfilled.

The steam and water piping should receive particular attention in connection with the general arrangement of the machinery.

Types of Pumping Engine.—Space will not permit of a detailed reference to the many different designs of pumps which have been developed to date. Special pumping machinery should occupy a separate chapter and a fairly long one at that. Under certain conditions it may be advisable to use some special form of pump in a water-works pumping station as, for instance, the air lift in connection with a widely distributed well development and where water cannot be raised to the pumps through the influence of the vacuum maintained in the suction line. Ejectors are used largely at this time under certain conditions. The development of the gasoline and producer gas engine has introduced another type of prime mover into pumping stations, and to-day there are a number of electrically driven plants. The futility of attempting to cover the entire field in a short paper is apparent, and I shall confine my remarks to what, at this time, may be termed the standard type of steam pumping station. Steam pumping engines for water supply and sewage discharge may, at this time, be divided into two general types—"Reciprocating" and "Centrifugal." I have attempted to give a general classification of these types in the accompanying diagram. (See Plate 71, Fig. 2.)

Selection of Type.—In designing a pumping station one of the first and most difficult problems is the selection of the most economical type of pumping engine, best suited to the immediate service conditions. By most economical, I do not mean the cheapest in first cost, nor that pump which will give the highest efficiency. Between these two limits there is an economical mean. The determination of this mean involves the total cost of pumping. It is customary in water-works plants to report the cost of pumping, based on pumping station operating expenses, including attendance, coal, oil, fuel, repairs, etc., but the interest and sinking fund charges, together with the depreciation on the plant, are equally

-PUMPING STATISTICS AND COST OF PUMPING AT WATER WORKS PLANTS IN VARIOUS CITIES AND VILLAGES.-

No.	Pumping Statistics. Pumpage for the Year. Million Gallons.	Pumping Statistics. Aver. Head Pumped Against Ft.	Pumping Statistics. Duty per 100 Lbs. of Coal. Million Ft. Lbs.	Cost.- Based on Pumping Station Expenses. Per Million Gallons pumped.	Cost.- Based on Pumping Station Expenses. Per Mi. Gals. raised 1' high.	Remarks.	No.	Pumping Statistics. Pumpage for the Year. Million Gallons.	Pumping Statistics. Aver. Head Pumped Against Ft.	Pumping Statistics. Duty per 100 Lbs. of Coal. Million Ft. Lbs.	Cost.- Based on Pumping Station Expenses. Per Million Gallons pumped.	Cost.- Based on Pumping Station Expenses. Per Mi. Gals. raised 1' high.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	32.8	185	8.40	56.85	0.31		27	(2) 855.2	263	90.89	11.84	0.04	
2	(1) 39.7	322	29.66	57.31	0.18		28	(1) 856.3	302	98.00	11.57	0.04	
3	(2) 53.3	289	31.92	30.11	0.10		29	961.0	172	44.40	15.75	0.09	
4	(2) 67.9	240	23.43	44.05	0.18		30	1,088.0	401	53.10	20.65	0.05	
5	70.9	389	22.55	44.36	0.11		31	1,095.0	210	67.70	15.27	0.07	
6	73.0	115	6.90	83.02	0.72		32	(2) 1,104.7	204	86.65	12.63	0.06	
7	95.0	321	88.01	24.78	0.08		33	1,155.6	217	49.40	15.89	0.07	
8	105.8	250	46.90	11.15	0.04		34	1,206.4	186	76.48	10.80	0.06	
9	118.2	280	38.22	30.29	0.11		35	1,322.0	120	64.27	5.68	0.08	
10	(1) 158.4	252	40.92	29.10	0.12	Note	36	(2) 1,404.6	128	103.82	4.65	0.04	
11	(2) 203.8	208	38.48	20.79	0.10	(1)-without	37	1,861.4	240	54.79	8.35	0.04	Imperial Gallons.
12	208.9	176	41.37	18.50	0.10	slip allow-	38	1,909.8	164	78.34	16.29	0.10	
13	237.2	322	46.45	25.75	0.08	ance.-	39	(1) 2,693.6	130	123.76	5.22	0.04	
14	(2) 246.1	232	32.85	26.53	0.11	(2)-with	40	(2) 2,718.3	184	134.76	6.61	0.04	
15	250.0	70	25.56	11.51	0.16	slip allow-	41	(1) 2,909.4	287	95.88	5.28	0.02	
16	262.6	98	30.80	23.92	0.24	ance.-	42	2,920.0	180	29.80	21.58	0.12	
17	(1) 272.8	182	43.81	17.12	0.09		43	(1) 3,659.5	235	72.35	4.51	0.02	
18	350.0	179	17.90	18.06	0.10		44	3,678.6	183	125.08	4.69	0.02	
19	(1) 364.9	316	34.54	24.74	0.08		45	4,188.4	437	104.91	11.84	0.03	
20	372.3	199	31.60	25.08	0.13		46	7,957.9	118	60.50	2.82	0.02	
21	438.0	185	42.90	21.78	0.12		47	9,111.8	199	111.77	3.44	0.02	
22	(1) 502.2	140	62.53	13.67	0.10		48	(1) 10,708.5	130	138.84	3.03	0.02	
23	(1) 542.6	246	87.94	10.38	0.04		49	11,293.9	164	102.46	4.44	0.03	
24	580.1	292	76.68	19.25	0.07		50	17,130.3	126	116.18	3.10	0.02	
25	617.3	231	35.23	42.69	0.18		51	(1) 19,183.4	46	108.38	1.68	0.04	
26	(2) 660.4	216	48.29	15.22	0.07		52	(1) 27,816.8	132	87.95	3.35	0.01	

FIG. 1.

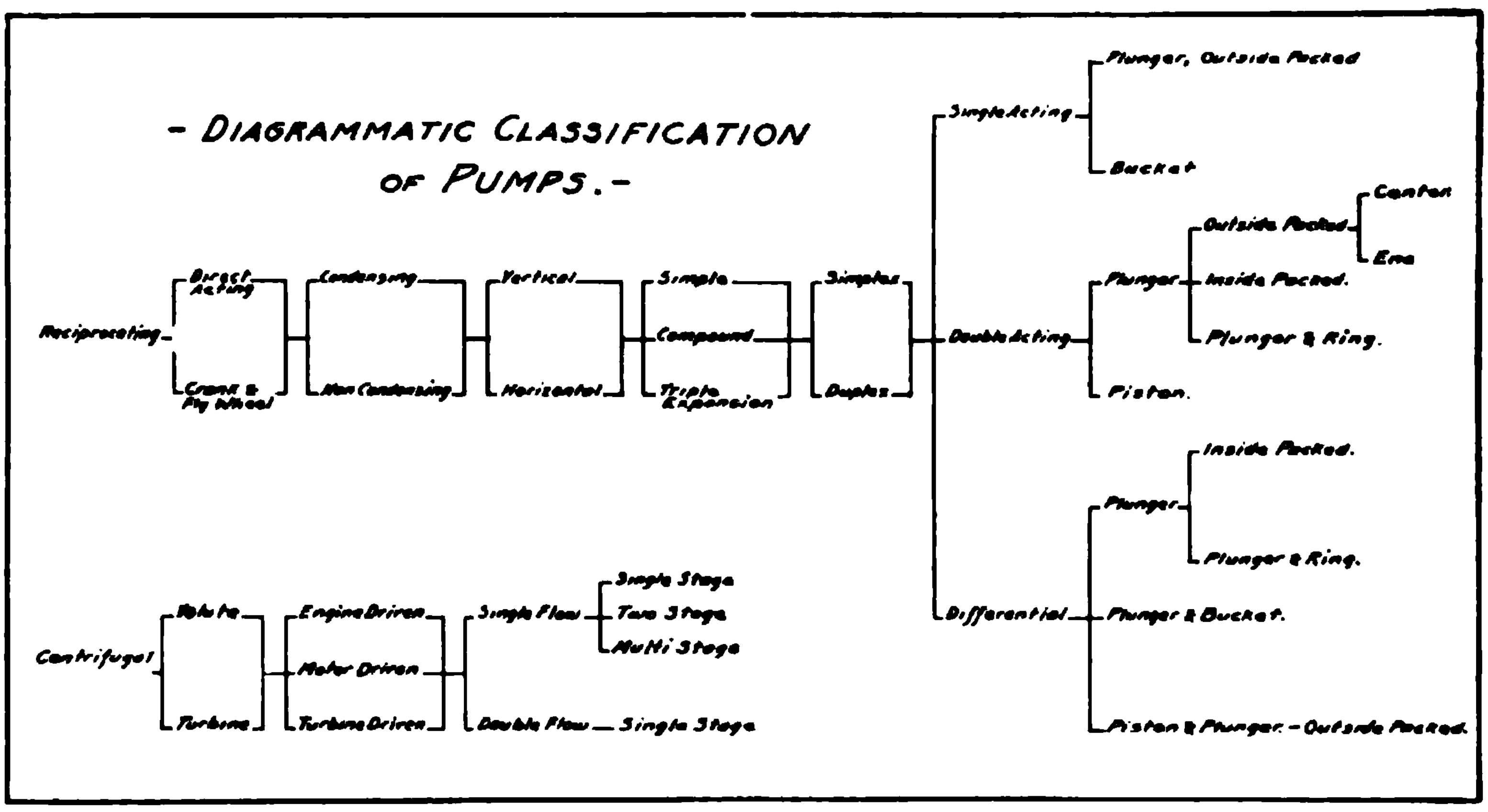


FIG. 2.

as important when considering the most economical type of engine to select. It does not necessarily follow that the engine with the highest duty is the least costly to install, for the reason that the fixed charges may be sufficiently great to offset the reduced cost of operation resulting from fuel saved.

The duty of the same engine will, of course, vary materially with the service to be rendered. Under constant load and high head, the duty of reciprocating engines is the greatest. A variable, or intermittent load materially reduces the efficiency of any engine, and hence under these conditions high efficiencies are not warranted by the saving in cost to be effected. (See Plate 72, Fig. 1.) This diagram illustrates the effect of a variable load upon the steam consumption of a simple non-condensing engine. While the curves are not precisely applicable to a particular pumping engine they are characteristic of the effect of variable loads. It is seen that the steam consumption per indicated horse power, at the rated horse power (120) of the engine in question, is about 27 lb., whereas, at $\frac{1}{3}$ load, or 40 h.p., the steam consumption amounts to 64 lb. per i.h.p. Also the total steam consumed per hour increases only from 2 600 lb., at $\frac{1}{3}$ load, to 3 300 lb. at full load.

The cost of coal can be determined from the following formulæ.

Where the guaranteed duty of an engine is known, and when duty is expressed in foot-pounds per 1 000 lb. of steam, then pounds of steam per i.h.p. $= 60 \div \dfrac{\text{Duty}}{33\,000 \times 1\,000} = \dfrac{1\,980\,000\,000}{\text{Duty}}$.

The steam consumption corresponding to various duties may also be obtained from Plate 73, Fig. 1.

The annual cost of fuel $= \dfrac{S \times \text{i.h.p.} \times T \times C}{E \times 2\,000}$.

In which S = pounds of steam used by the pumping engine per h.p. per hour;

i.h.p. = average indicated horse power developed;

T = number of hours during the year pumping is required;

C = cost of coal in dollars per ton of 2 000 lb.;

E = evaporation factor of the boiler which equals approximately 8 lb. of water evaporated per pound of ordinary good bituminous coal.

To the cost of coal thus determined there should be added, say, 4 to 6% interest, on the cost of the engine, 8 to 10% for repairs, depreciation, etc., and 1 to 2% refunding sinking fund.

No really reliable figures on the cost of pumping engines can be given. Such figures vary with the type, size, head pumped against, steam pressure, as well as with supply and demand and the cost of materials.

If an engineer is in doubt as to the type of pumping engine needed for a special situation, bids on the types that are to be considered should be obtained, and from the prices thus obtained a decision may be made.

In order, therefore, to fix upon the cheapest unit for a particular case it is necessary to consider the following elements:

(*a.*) The first cost of the engine.
(*b.*) The cost of foundations.
(*c.*) The cost of land.
(*d.*) The cost of building required to house the engine.
(*e.*) The efficiency of the engine.
(*f.*) The cost of the boilers necessary to supply steam to the engine.
(*g.*) Cost of coal per ton.
(*h.*) The cost of maintenance and repairs, lubricants and waste.
(*i.*) The cost of any other elements which may be affected by the type of engine selected.

It frequently occurs that the cost of foundations for one type of engine are considerably more than for another, and, similarly, the cost of the building required to house a certain type of engine will be greater than for another. The engine to be purchased, therefore, should be charged or credited with these costs in order to accurately fix upon the total fixed charge involved.

A vertical type of engine of the same capacity occupies less floor space than a horizontal, and where land is extremely high, a big saving may be affected in floor space, and hence in initial cost, by installing this type of engine. For vertical engines, however, the sub-foundations are usually heavier and more costly than those required for the horizontal type. This is especially true where the materials encountered make foundation work expensive. If these costs are weighed, the results might show greater economy in the

PLATE 72.
THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK.
HILL ON WATER-WORKS
PUMPING STATIONS.

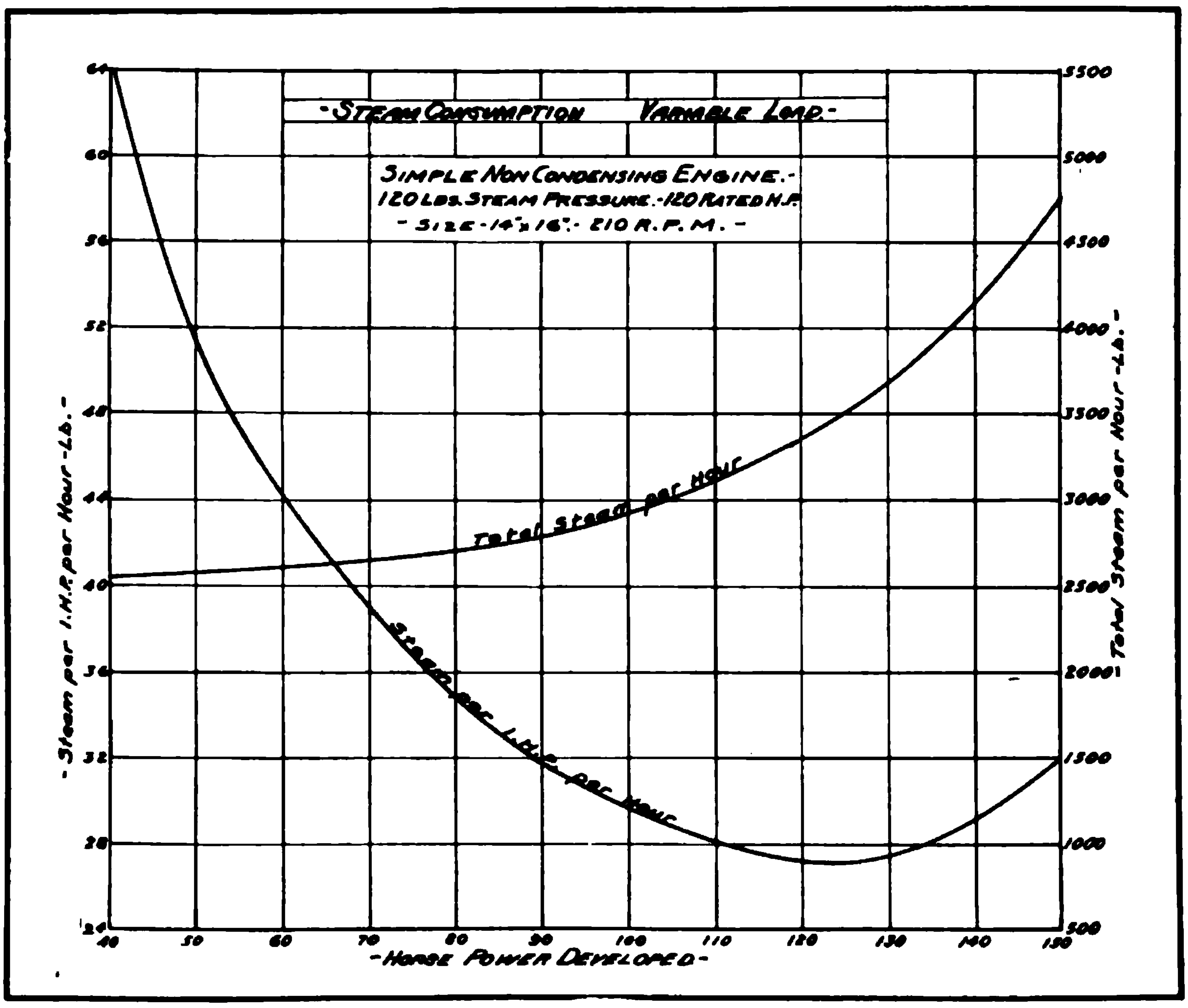


FIG. 1.

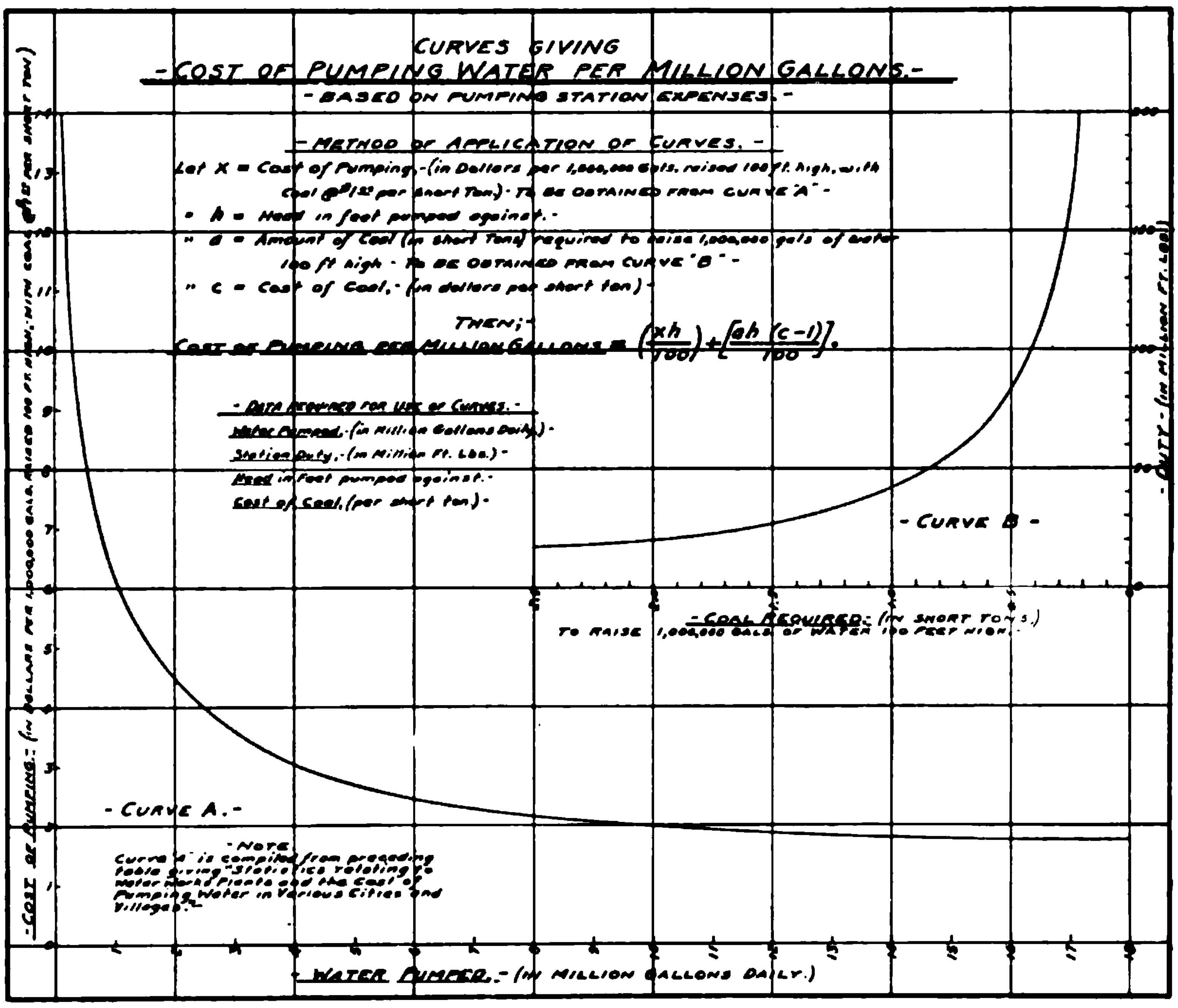


FIG. 2.

horizontal engine. For horizontal engines the condenser can usually be placed in the discharge line in such a manner as to reduce the basement required to a minimum. The height of a building required for vertical engines is greater than for horizontal, and, although the floor space occupied by the horizontal type is greater than for the vertical, the difference in the height of the buildings and basements will sometimes make the station for a vertical equipment more costly than for the horizontal type.

The lower the efficiency of the engine, the larger the boiler plant required to furnish steam. This is exemplified by the table shown on Plate 73, Fig. 1. The added cost of boiler power required for engines with lower efficiency should be charged to this type of unit.

As engines of low efficiency require a greater amount of steam, it sometimes happens that the cost of steam piping is enhanced when they are specified for use.

The prevailing price for coal has a decided influence upon the type of engine to be selected. Where coal is cheap it is evident that greater efficiency will produce a smaller proportionate saving than where coal is high.

For handling small quantities of water, the item of fuel usually becomes a secondary consideration, so far as the selection of type of pump is concerned, and the pump which is lowest in first cost, in most cases, will be found to have the field unchallenged. The capacity of the plant, in which the fuel saving to be effected by higher efficiency warrants the purchase of high priced machinery, depends largely upon the price of coal, as well as other local considerations, and although there has been some effort to fix an arbitrary point at which it pays to go into high duty engines, it is only possible to do so by careful estimate.

The cost of maintenance, including attendance and repairs, is frequently greater for engines of the highest economy than for units of lower efficiency. (See Plate 73, Fig. 2.) This table gives a tabulation of the cost of an entire station in detail, with three types of engines, including the installation of superheaters and economizers, together with an electric light plant. In this case land is not included, because the property had already been purchased, but the table indicates the relative first cost of the plant equipment.

This table also gives the total cost of the station above the base-

ment floor, as indicated in its upper portion, together with an estimate of the operating expenses and fixed charges for the three styles of equipment. The result of this tabulation shows a saving of, approximately, $190 000 upon the first cost of installation in favor of the horizontal cross compound type of engine, as compared with the vertical triple, and a saving of $15 000 per year, including interest, fixed charges and operating expenses, in favor of the same type of engine.

In presenting this table, it is not to be understood to indicate any preference for a particular style of engine. The tables are given as a method of determining upon the best type of engine to select. Local conditions, in the particular estimate presented, worked out in favor of the horizontal, cross compound type, although, generally speaking, in stations for large municipalities, the vertical triple expansion type of engine is found to be more economical to install, notwithstanding the fact that the first cost is greater than for other types of engines. Other factors than the economical value of the pumping unit, must be considered in making a selection. One type or another of pump may be best suited to the local conditions.

The recent improvements in design in centrifugal pumps, their greater efficiency and low first cost, have brought them prominently to the notice of the engineer. Like most other designs of pumping machinery, centrifugal pumps adapt themselves better to some conditions of service than to others. A pump of this type finds itself in many cases in competition with the best forms of vertical triple expansion, or horizontal, cross compound pump (at least when proposed for large units), and while the latter types are capable of giving a better efficiency, the centrifugal pump is in many instances the best form of pump to install. If, however, the centrifugal pump is to give the most economical results, and at the same time permit of moderate first cost, it is necessary that the pump should run at the highest possible speed consistent with safety and low maintenance charges and that the capacity of the pump and the head should be in a suitable ratio. (See Plate 74, Fig. 1.)

In regard to the first point, the most important factor limiting the number of revolutions in the *turbine* type of centrifugal pump, is the quality of the water passing through the pump. If the water

BOILER-HORSE-POWER REQUIRED FOR EACH PUMP-HORSE-POWER COUNTING 10 SQ. FT. OF HEATING SURFACE FOR EACH BOILER-HORSE-POWER, FOR THE FOLLOWING DUTIES OF ENGINES.

DUTY IN FT. LBS. PER 1000 LBS. STEAM.	LBS. OF STEAM PER HOUR PER PUMP-H.P.	BOILER HORSE POWER PER PUMP HORSE POWER.
40,000,000	49.50	1.63
50,000,000	39.60	1.32
60,000,000	33.00	1.10
70,000,000	28.38	0.94
80,000,000	24.75	0.83
90,000,000	22.00	0.74
100,000,000	19.80	0.66
110,000,000	18.00	0.60
115,000,000	17.21	0.57
120,000,000	16.50	0.55
125,000,000	15.80	0.52
130,000,000	15.20	0.51
135,000,000	14.66	0.49
140,000,000	14.14	0.47
145,000,000	13.65	0.46
150,000,000	13.20	0.44
155,000,000	12.77	0.43
160,000,000	12.37	0.41
165,000,000	12.00	0.40
170,000,000	11.65	0.39
175,000,000	11.31	0.38
180,000,000	11.00	0.37
185,000,000	10.70	0.36
190,000,000	10.42	0.35
195,000,000	10.01	0.34
200,000,000	9.90	0.33

FIG. 1. (From Hague).

- ESTIMATE OF COST OF CONSTRUCTION - AND YEARLY COST OF PUMPING. - FOR PUMPING STATIONS WITH DIFFERENT TYPES - OF PUMPING ENGINES. -

- ITEMS. -	TYPE OF PUMPING ENGINES.		
	Horizontal Cross Compound	Horizontal Triple Expansion.	Vertical Triple Expansion
(1)	(2)	(3)	(4)
- COST OF CONSTRUCTION -	$	$	$
Engines. - (Four)	237,000.00	304,000.00	425,000.00
Engine Foundations. -	8,500.00	12,600.00	
Boilers & foundations required for complete station.	45,000.00	41,500.00	41,500.00
Superheater. -	11,000.00	11,000.00	11,000.00
Economizer. -	16,000.00	16,000.00	16,000.00
Chimney. - (Radial Brick.)	10,000.00	10,000.00	10,000.00
Buildings required for complete station. -	60,000.00	72,000.00	72,600.00
Centrifugal Pumps. -	18,000.00	18,000.00	18,000.00
Four Valve Engines for Centrifugal Pumps.	24,500.00	24,500.00	24,500.00
Foundations for Centrifugal Pump and Engines. -	1,000.00	1,000.00	1,000.00
Generators, Engine Switchboard and foundations. -	20,300.00	20,300.00	20,800.00
Steam Piping. -	10,000.00	10,000.00	10,000.00
TOTAL COST OF STATION; above Basement Floor, not including sub-foundation, suction intake, discharge piping. -	461,300.00	540,900.00	650,400.00
- YEARLY COST OF PUMPING. -			
Fuel. -	90,000.00	83,000.00	80,000.00
Wages. -	20,000.00	20,000.00	20,000.00
Repairs to Machinery. -	5,400.00	6,300.00	8,100.00
Supplies, Oil & Waste. -	5,000.00	5,500.00	5,500.00
Interest and Depreciation. -	39,200.00	46,000.00	55,300.00
Refunding Sinking Fund. -	13,950.00	16,350.00	19,670.00
TOTAL YEARLY COST OF PUMPING.	173,550.00	179,150.00	188,570.00

FIG. 2.

is clean, a high speed may be selected, with every advantage so far as the pump is concerned. Should there, however, be a large percentage of grit in the water, then, of course, the speed of the turbine should be as moderate as possible in order to prolong the life of the internal parts of the pump.

Where dirty water is to be handled the volute type of centrifugal pump is probably better adapted for service. There are fewer short bends and less friction in the volute type than in the turbine, and where conditions admit of the pump being placed close to the water supply, the volute centrifugal is possibly the more economical to install, although some may disagree with this view.

In either the turbine or volute type of centrifugal pump as the quantity increases so the efficiency will increase, and where the head is greatly in excess of the quantity, the reciprocating pump will generally give the best results. Each case, however, must be considered on its merits, for there are many instances in which the low first cost, economy of space, low cost of up-keep and general convenience of arrangement of the volute or turbine types of centrifugal pump will give them a distinct preference over the reciprocating type.

The difference between the turbine and the volute types of pump is that diffusion vanes are used in the turbine pump. The diffusion vanes are so formed as to provide gradually enlarging passages from the periphery of the impeller to the volute, or discharge chamber, the purpose of these passages being to receive the water without shock as it leaves the impeller and to allow it to slow down gradually as it approaches the volute chamber, converting the velocity head into pressure head. There is no fixed policy with regard to the use of diffusion vanes. Some designers prefer them and some prefer the volute type without diffusion vanes. Diffusion vanes are accurate only when the pump is operated at exactly its rated head and speed. If any change in either the capacity, head, or speed of the pump is made, the diffusion vanes become less efficient for they then to some extent obstruct the passage of the water. In order that diffusion vanes may be efficient their entering edges must be very sharp and in close proximity to the revolving vanes of the impeller and this results in rapid erosion of both diffusion vanes and impeller blades if the liquid to be handled is gritty or dirty. If the centrifugal

pump to be installed is to be subjected to great variations in load, it is probable that the volute type will work better under all conditions, although there is some difference of opinion on this score.

It may be well to mention here the adaptability of electrically driven centrifugal pumps to small pumping stations where electric power may be cheaply obtained. Turbine driven centrifugal pumps make a compact and effective unit. (See Plate 74, Fig. 2.)

There are many locations where pumps are required for occasional service only, as for instance in fire service stations, where centrifugal pumps may be used with special advantage.

The centrifugal pump has a large and rapidly widening field. but until its efficiency is improved so as to remove its present handicap in economy it can hardly be expected to displace the reciprocating pump in general water-works service. It is true, however, that when the difference in maintenance, oil required, valve renewals and sustained efficiency and interest on low first cost is capitalized, the centrifugal is in many cases on a par with reciprocating pumps for water-works service.

In brief, the field of the centrifugal pump is chiefly in handling large quantities of water at low heads, and usually it can only be considered for high heads when the quantity of water to be handled is relatively small or, to be more explicit, in small plants.

With regard to the choice or adaptability of engines of the reciprocating type for particular services, enough has been said in the outline which precedes to indicate where engines giving low duty and those giving high duty are usually found to yield the lowest cost for pumping, but in the selection of any type of engine the study of the conditions should take into consideration the station duty and, in no circumstances, the test duty. It should also be borne in mind that in no water-works pumping station does any engine operate at its full normal capacity 100% of the time. Therefore, in apportioning the charges for or against any one type of engine, some estimate should be made of just what percentage of the time and at what average rate, or average percentage of its normal rate, the pump which is selected will be called upon to work during its lifetime. This element of consideration is often eliminated from estimates, which are frequently based upon the erroneous assumption that the pump, once set up, is going to run right along at full speed until it is

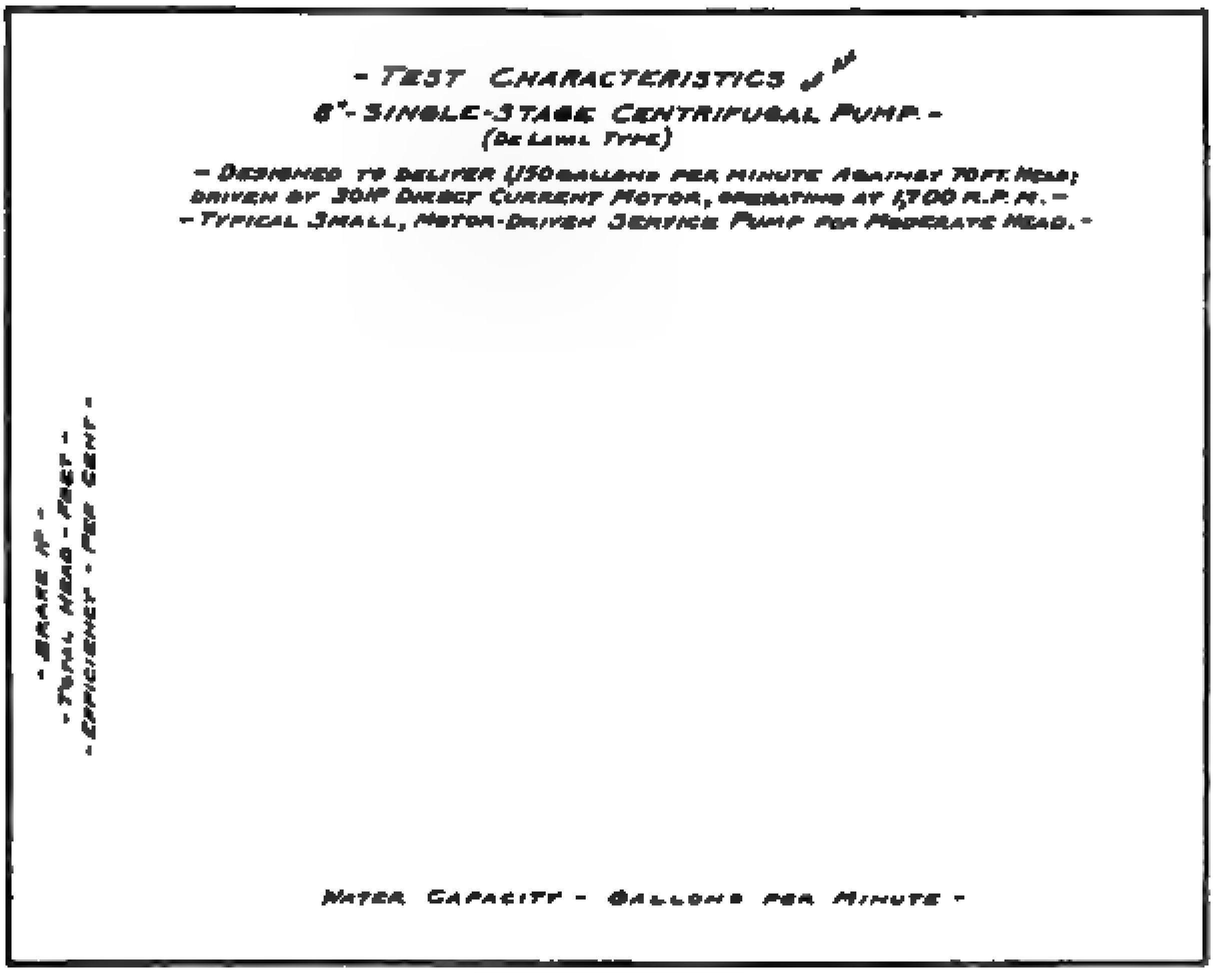

- TEST CHARACTERISTICS of
8"- SINGLE-STAGE CENTRIFUGAL PUMP. -
(De Laval Type)
- Designed to deliver 1,150 gallons per minute against 70 ft. Head;
driven by 30 HP Direct Current Motor, operating at 1,700 R.P.M. -
- Typical Small, Motor-Driven Service Pump for Moderate Head. -
- Brake HP -
- Total Head - Feet -
- Efficiency - Per Cent -
Water Capacity - Gallons per Minute -

Fig. 1.

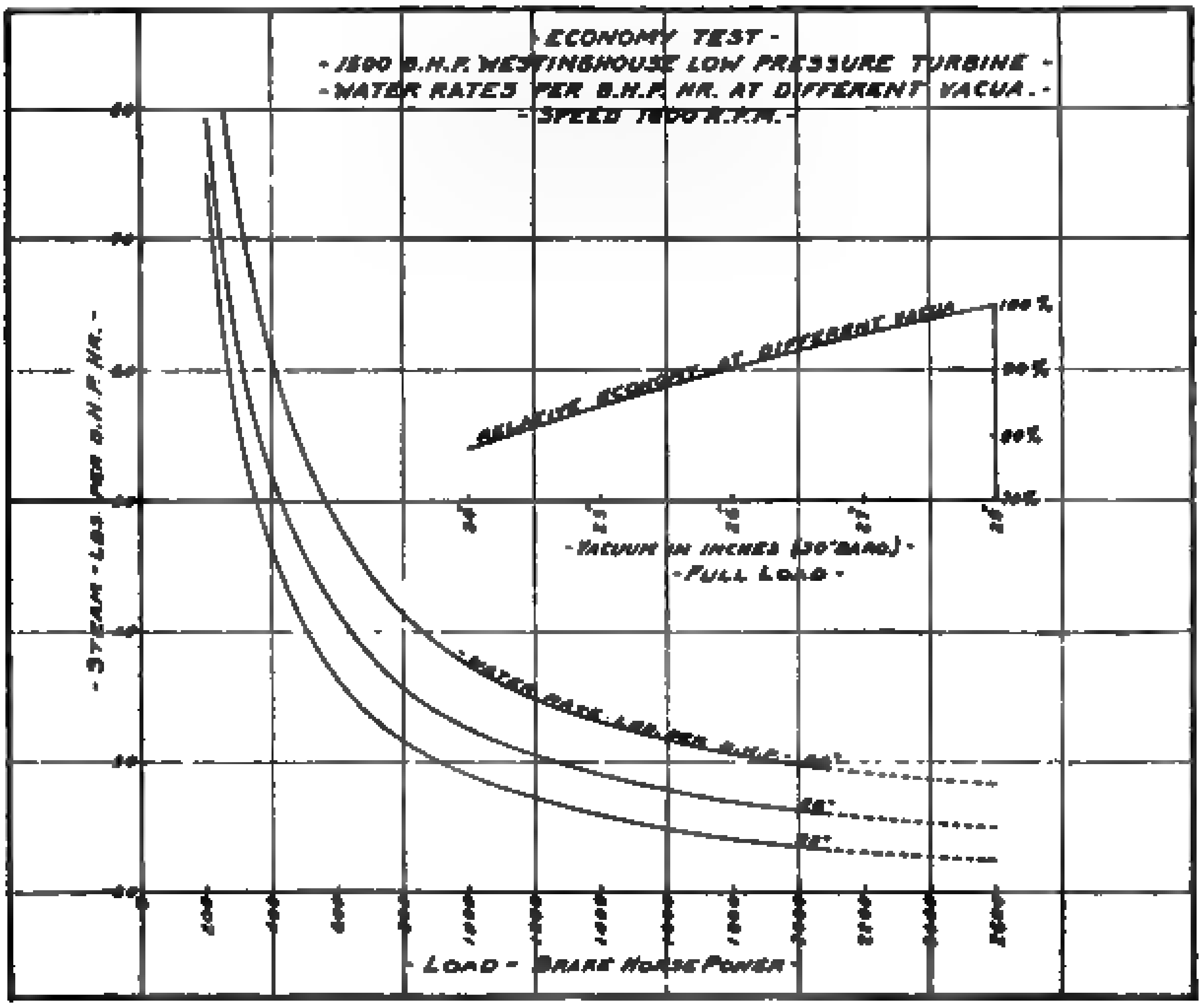

- ECONOMY TEST -
- 1500 B.H.P. WESTINGHOUSE LOW PRESSURE TURBINE -
- WATER RATES PER B.H.P. HR. AT DIFFERENT VACUA. -
- SPEED 1800 R.P.M. -
RELATIVE ECONOMY AT DIFFERENT VACUA
100 %
90 %
80 %
70 %
- Vacuum in inches (30" Barо.) -
- Full Load -
- Water Rate - Lbs. per B.H.P. -
- STEAM - LBS. PER B.H.P. HR. -
- LOAD - BRAKE HORSE POWER -

Fig. 2.

relegated to the scrap heap. This is especially important, as the efficiency of the engine at half-load is very much less than when running at its rated capacity, and hence the theoretical engine duty obtained on test is really not a true measure of the results which will be obtained in actual operation. Moreover, as the quantity of coal used bears some proportion to the hours of pumping, the amount of coal saved by higher efficiency is necessarily reduced with shorter hours and hence the reduction in operating cost is lessened and there is a smaller sum available to offset the increased interest charges which usually accompany high duty machines.

The stand-by losses reduce the net efficiency materially where the pump is operated but a portion of each day, and it may be said, generally, that it hardly pays to go into the most expensive forms of pumping machinery when the engine is to be run at a fraction of its rated capacity, or where it is to be operated only a portion of each day.

This brings up a common error in the design of water-works pumping stations. It is usual to take the maximum total pumping capacity required, subdivide this into pumping units of equal capacity. That is to say, if there are one hundred million gallons a day to be pumped, it is usual to install, say, five 20 mill. gal. pumps. It will usually develop, however, that a sub-division of these units into different sizes will allow each unit to be operated at its full capacity, and far more economical operation in the consumption of coal will result than would be otherwise possible. In other words, it is good practice to give due consideration to the load factor on the station and the daily load curve, or the hourly variation in the quantity of water to be pumped. A little figuring will show that by an intelligent sub-division of the units, the station may be worked at its maximum efficiency for a large proportion of the day.

Design of Stations.—Having outlined in a very brief and cursory way the elements affecting the selection of the pumping unit, I will now try with as much brevity to indicate the lines of procedure with relation to the rest of the plant.

The first step is to determine the theoretical horse power required to pump the quantity of water desired, against the pressure which it is proposed to maintain.

The total head equals the static head on the mains, plus the friction head, plus the suction lift. This total head multiplied by the weight of the water to be pumped in one minute and divided by thirty-three thousand gives the theoretical horse power. Having determined the theoretical horse power (which is usually spoken of as the "water horse power") it is necessary to determine the mechanical efficiency of the pumping engine. (See Plate 75.) The mechanical efficiency of all engines vary, of course, with the size and type, but the table opposite shows the approximate mechanical efficiency of engines of different sizes. The quotient obtained by dividing the water horse power by the mechanical efficiency gives the theoretical indicated horse power.

Having determined the indicated horse power required, and having determined upon the type of engine to be installed, and knowing its duty, we can learn from the table shown on Plate 73, Fig. 1, the number of pounds of steam per i.h.p. required to be furnished by the boilers. It is usually safe, however, to provide in excess of the actual requirements of the engine, on account of the steam consumption of the auxiliaries and the losses due to condensation in the steam pipes, and for other reasons. As a rule, this amounts to about 10 to 15% of the steam actually consumed by the main pumping unit.

One boiler horse power is taken as the evaporation of 30 lb. of water per hour from a feed water temperature of 100° into steam at 70 lb. gage pressure, which is approximately equal to 34½ units of evaporation, that is, 34½ lb. of water evaporated from a feed water temperature of 212° into steam of the same temperature. It is simpler for the purpose of general design, and at the same time usually allows a slight factor of safety, if we use 30 lb. of water evaporated into steam as a boiler horse power and provide this capacity for the pumping station.

The term "horse power" is frequently used when estimating capacity of steam boilers, and it is the custom of buyers to ask for boilers of a certain horse power. This is an improper way to buy boilers unless the amount of heating surface per horse power is clearly known. If a purchaser calls for boilers of a given horse power, one bidder might offer a boiler with ample heating surface, while another might offer a boiler with much less. Both may

Mechanical Efficiency of Pumping Engines: Showing the Indicated Horse Power in the Steam Cylinders.

Capacity U.S. Gallons per 24 Hours.	Total Water Load against the Plunger in Pounds Pressure, Including Suction												Mech. Eff. in % of Indicated Power
	40	50	60	70	80	90	100	110	120	130	140	150	
	Indicated Horse Power of the Steam Cylinders												
1,000,000	20	25	30	35	40	46	60	55	60	65	70	75	80
1,500,000	30	37	44	52	58	66	74	81	90	96	104	111	81
2,000,000	40	50	60	70	80	90	100	110	120	130	140	150	82
2,500,000	48	60	72	82	96	110	120	133	145	160	170	180	83
3,000,000	55	71	84	100	114	128	143	157	171	185	200	214	84
4,000,000	75	94	113	132	150	170	188	207	226	245	264	283	85
5,000,000	93	116	140	161	186	210	234	255	280	304	325	350	86
6,000,000	110	138	166	205	220	248	276	303	330	360	386	415	87
7,000,000	129	161	194	225	257	290	322	355	387	418	450	484	87
8,000,000	146	182	218	255	291	328	364	400	435	474	510	547	88
9,000,000	164	205	245	286	328	368	410	450	492	532	572	614	88
10,000,000	181	225	270	315	360	405	450	495	540	585	630	675	89
11,000,000	198	247	296	346	395	446	495	543	592	642	690	740	89
12,000,000	214	266	320	375	426	480	534	585	640	692	750	800	90
13,000,000	231	289	346	404	464	520	579	638	694	745	809	869	90
14,000,000	246	308	370	430	494	554	617	676	740	800	860	923	91
15,000,000	264	330	396	461	529	593	660	726	790	860	922	990	91
16,000,000	278	348	418	488	556	627	699	767	832	906	975	1043	92
17,000,000	296	370	444	520	591	666	740	810	888	960	1034	1109	92
18,000,000	310	388	465	541	619	696	775	852	930	1006	1042	1162	93
20,000,000	345	430	518	602	689	775	861	946	1033	1120	1205	1290	93?
22,000,000	375	458	560	655	760	843	990	1030	1123	1266	1310	1406	94
25,000,000	426	532	639	745	850	954	1065	1173	1278	1381	1491	1596	94
30,000,000	505	631	800	885	1010	1138	1262	1390	1519	1640	1772	1895	95
35,000,000	590	738	885	1033	1180	1325	1478	1622	1772	1918	2063	2219	95
40,000,000	668	833	1000	1168	1335	1500	1669	1858	2025	2165	2340	2500	96

(From Hague).

develop the required horse power, but the one with the insufficient heating surface might do it only at an increased cost for fuel.

Each square foot of heating surface of the boiler can transmit only a certain amount of heat when the highest economy is being realized. By increasing the supply of heat, a greater amount is transmitted, and consequently, a greater amount of water is evaporated by each square foot of heating surface, but, with the increase, the same percentage of the heat is not utilized. The reason is that after a certain rate of evaporation is reached, the maximum capacity of the metal of the boiler plates to transmit the heat is very nearly reached, and hence a large percentage of the heat and fuel passes up the chimney.

Boilers should not be bought which provide less than 1 sq. ft. of heating surface for every 3 lb. of water to be evaporated, in other words, with not less than 10 sq. ft. of heating surface per b.h.p. It will usually be found good practice and economical to provide reserve power in the boilers and ample heating surface, particularly if the boiler plant is designed on the test duty of the engine, which is never realized in actual practice.

The best efficiency under ordinary working conditions is usually obtained by allowing very nearly 12 sq. ft. of heating surface per b.h.p.

Some water tube boilers with certain coals seem to give good results when the heating surface per horse power is a little less than that stated, and it is customary even at this time to provide much less heating surface than here specified with the internally fired type of marine boilers, although, for pumping station work, this practice should not be followed.

Such high results with most boilers are usually attained when all of the many conditions affecting efficiency are such as to produce the best results. Many of these conditions are not so favorable when the boiler is operated in ordinary service. For instance, if the boiler surfaces are not clean, owing perhaps to the accumulation of scale or soot, the efficiency of the heating surface will be more or less impaired. This will almost certainly happen in the average water-works pumping plant. For this, and other reasons, it is well to provide ample heating surface for the work to be done, for not only will such a course result in saving fuel at ordinary rates of evapora-

tion, but it makes it possible to run the boiler considerably above its rating and maintain a fair degree of efficiency. Where fire service is furnished at the pumping station, reserve power may serve a most useful purpose.

Division of Heating Surface into Units.—The first problem connected with the design of the boiler plant is to determine accurately the maximum number of pounds of steam that will be used by the various pumping engines as well as other parts of the plant that will have to be supplied. As previously explained, and as has already been said, one square foot of heating surface at least should be allowed in most boilers for every 3 lb. of water to be evaporated into steam. With this proportion and sufficient draft and grate surface, to burn the necessary amount of coal, a boiler can be forced about 33% over its rated capacity. It ought to be stated, however, that the maximum evaporation of a boiler is limited mainly by the amount of coal which can be burned upon the grate. By dividing the total number of pounds of steam that are to be evaporated per hour by three, the total amount of heating surface may be obtained with a fair degree of accuracy.

The next step is the sub-division of this heating surface into a proper number of boilers. This is of importance. Saving in first cost, and the cost of operation may result from proper sub-division.

Grate Surface.—To evaporate a given amount of water into steam, it is necessary to generate a certain amount of heat by the combustion of fuel. The factors controlling the amount of heat generated are, the kind of coal, the area of grate surface and the draft. Ample grate surface is desirable. The draft affects the rate of combustion.

The kind of coal to be used should be determined before designing the boiler plant, the cost of the various fuels available and their calorific value, or relative evaporative power. With these data, one can determine the cheapest kind of fuel, and each having been considered, can construct the boiler plant so that it can be used to the best advantage. Some plants are handicapped by failure to consider these questions.

With good coal, low in ash, approximately equal results may be obtained with large grate surface and light draft and with small grate and strong draft, the amount of coal burned per hour being

the same in both cases. Bituminous coal, low in ash, gives best results with high rates of combustion, provided the ratio of grate surface to heating surface is properly proportioned. Coals high in ash require a comparatively large grate surface, particularly if the ash is easily fusible, tending to choke the grate. Where a strong draft is available a smaller grate may be used than with moderate draft, as a thicker bed of fuel can be carried. The relation between draft and rate of combustion is also important.

If only a limited amount of coal can be burned on a grate, it must be made larger in proportion to the heating surface, and when it is intended to burn low grades of fuel, provision for a large grate ought to be made in the first place. Then, if it is later desired to change to a fuel of a better grade, this can be done by reducing the size of the grate by bricking off a portion of it.

If it is certain that there never will be a desire to operate a plant with a poorer grade of fuel than that for which it is designed, it would be uneconomical to provide larger grates than are necessary.

From a knowledge of the number of pounds of water to be evaporated and the amount that 1 lb. of coal will evaporate under ordinary conditions, the quantity of coal that will be consumed in a given time can be calculated, and, if the number of pounds of coal that must be burned is known as well as the amount of coal that should be burned on each square foot of grate surface in a given time, for the normal rate of evaporation. the amount of grate surface can be determined.

The following table gives a very approximate estimate of the relative evaporative power of several kinds of coal, or the water that one pound of coal will evaporate, the pounds of coal that may be economically burned per sq. ft. per hr., and the ratio of grate surface to heating surface with ordinary drafts.

	Pounds of water 1 lb. of coal will evaporate, with steam at 212° F.	Pounds of coal per sq. ft. of grate, per hour.	Ratio of heating to grate surface.
Best bituminous	9.0	21	55
Ordinary bituminous	8.0	20	46
Anthracite (nut or larger)	8.0	18	32
" (buckwheat or rice)	7.0	12	26

Type of Boiler.—There are three types of boilers now in general use for steam-making and it is not my intention to refer to the many variations in these types which have been developed from time to time.

1. The plain return tubular boiler set in brick work.
2. The fire-box boiler, or internally fired boiler of the marine type, which requires no brick setting and is complete when it leaves the boiler shop.
3. The water-tube boiler, set in brick work, with hot gases passing around the tubes, of which the Babcock & Wilcox is now the oldest and best known type.

One of the chief features in the selection of the type of boiler to be used is that of the steam pressure to be carried.

Return tubular boilers are made and offered in the market up to 84 in. in diameter and 20 ft. long to carry 150 lb. pressure per sq. in., but boilers of this type should rarely, if ever, be used for steam pressures exceeding 130 lb. per sq. in. The initial steam pressure where vertical, triple expansion engines are used frequently runs from 150 to 190 lb. per sq. in., and under these circumstances it is better to use another type of boiler than the horizontal tubular. If the initial steam pressure is reduced, then, of course, the purchaser has to pay the interest on the increased size of the steam cylinders of the engine.

High pressure steam, especially in compound or triple expansion engines, is conducive to higher economy, but it should not be forgotten that high steam pressure (and by that is meant pressure of 125 lb. and over) must increase wear on the system, give some trouble with steam piping if unusual care is not taken in constructing it, and produce an increased loss from leakage and condensation unless superheat is used; but for all of these objections, the higher economy of the engines with high steam pressure will more than compensate for the drawbacks if the plant is properly designed. In the latest large electric power stations, steam pressures as high as 200 lb. are used, and in marine practice the tendency has been towards higher steam pressure. In pumping stations in which it is necessary to develop the highest efficiency, higher pressure will also tend to economy.

For high pressures, 125 lb. per sq. in., or more, the water tube, or some form of internally fired boiler, in which the shell plates are not exposed to the high temperature of the furnace, is considered safer than the horizontal tubular boiler, because the shell plates and the seams of the latter must be of considerable thickness in large units, and, being exposed to the hottest part of the fire, are likely to give trouble, especially if the water contains scale or sediment forming elements. This type of boiler, however, for the pressures which it will safely carry, is economical in the use of fuel. There is a limit to the size of these boilers, however, owing to the fact that the thickness of the plate in the shell increases very rapidly as the diameter of the boiler is increased, and it is either necessary to lower the pressure carried in order to get large units, or else to install a number of units, where large amounts of power are required, and the duplication of units and boiler settings is expensive. Return tubular boilers are seldom made in sizes over 200 h.p., and hence are not to be considered for large units.

The internally fired type of boiler is very popular in marine circles, and it is advantageous in economy of space, the saving in the cost of repairs to brick settings and its good steaming qualities, although, if properly made, it is not a cheap boiler. In fact, internally fired boilers are more expensive than externally fired, though the extra cost of setting and foundations of the latter may bring the total cost of the entire equipment to practically the same figure. The internally fired boiler, with corrugated fire boxes, of the Fox or Morrison type, is an excellent boiler for high steam pressure and will meet all of the conditions now set up for modern boilers.

The water tube boiler is particularly advantageous in view of the fact that high pressure may be carried with perfect safety. The water tube boiler is usually employed in large central stations with high pressure and units of from three to five hundred horse power. It is possible that this boiler has led in the advance of steam pressure and the engine economy resulting therefrom, and that the development of the modern high duty engine has followed in its wake. The danger from explosions in stationary practice is now largely reduced by the water tube boilers and this feature of the boiler has made it popular in water-works pumping stations for the

reason that the fire hazard of a town, as well as the comfort of the people, is entirely dependent upon the safety and permanency of the water supply.

The economy with which different types of boilers operate depends far more upon their proportions and the conditions under which they work than upon their tpye. It is certainly true that when the proportions are suitably carried out, and when the conditions are favorable, the different types of boilers give substantially the same efficiency.

As previously mentioned, the water tube boiler has a decided advantage, so far as safety is concerned. Water tube boilers seldom, if ever, explode, although the tubes sometimes burst. Water tube boilers also possesses a slight advantage in that they contain less water within the shell than the usual designs, and consequently, steam can be raised in them very quickly. On the other hand, this type of boiler is very flashy and it is harder to maintain a uniform steam line than with the horizontal tubular boiler, or the internally fired marine type of boiler.

As in the case of pumping engines, the selection of the type of boiler must be a question to be determined with each individual plant.

The relative merits of a boiler should be considered with referference to—

1. Durability.
2. Accessibility for repairs.
3. Facility for cleaning and inspection.
4. Space requirements.
5. Adaptability to the type of furnace and stoker desired.
6. Capacity.
7. Cost of boiler and setting.

Superheat.—The installation of a superheater is equivalent to an increase in boiler capacity. Superheaters may be independently fired, or may be arranged in connection with the boiler proper. Engineers are not agreed as to which arrangement gives the most economical returns. The requirements for a successful superheater are:

1. Security in operation, or minimum danger of overheating.
2. Economical use of heat applied.

3. No exposure of joints to the fire.
4. Provision for free expansion.
5. Disposition such that they can be cut out or repaired without interfering with the operation of the plant.
6. Ease of application to existing plant.

Nearly all superheaters depend upon carrying steam at a high velocity through small tubes in the form of return bends, or coils, and arranged so as to be heated by the hot gases in the boiler furnace, or from some other source.

The independently fired superheater has the following advantages:

1. Degree of superheat may be varied, independently of the performance of the boiler.
2. It can be placed at any desirable point.
3. Repairs can readily be made without shutting down the boilers.

Some of the disadvantages are:

1. It requires separate firing and extra attention.
2. Extra piping is required.
3. Extra space is required.
4. Initial cost is greater.

The standard practice in this country seems to tend towards the superheater contained within the boiler setting.

The original tendency with superheating was to superheat the steam several hundred degrees, but the practice of installing superheaters in pumping stations has pretty clearly developed the fact that for this service 100° of superheat is amply sufficient. This corresponds to an increase of from 8 to 10% in the horse-power of the boiler, produced in the superheater. This degree of superheat also insures practically dry steam at cut-off, and, therefore, produces a material reduction in the losses due to cylinder condensation. Higher temperatures are apt to interfere with lubrication and sometimes cause warping of the valves. That the subject of the effect of superheat on pipes, fittings and valves in general is of vital interest to the engineer there can be no question. The constantly increasing use of superheated steam is bringing us face to face with some entirely new problems and modifying some of

iaries only to be used for feed-water heating purposes, and, if the feed water supply is cold, the heat contained in the exhaust from the auxiliaries is rarely sufficient to raise the temperature of the feed water to more than 100° to 125° Fahr.

As between attached auxiliaries driven by the main engine and independent auxiliaries, the exhaust steam of which is used for feed-water heating, I am inclined, from some years' observation, to believe that the independent auxiliaries work out more economically, as practically every bit of the heat in the exhaust steam from the independent units is returned to the boiler through the feed water. This observation, however, is capable of modification when economizers are used.

With condensing apparatus in conjunction with the main pumping unit and a temperature of 100° or 125° in the boiler feed water as a result of the use of exhaust steam from auxiliaries, there is room for consuming other waste heat. It is well to carry all the condensation from the jackets on the main engines as well as from the steam supply piping to a hot well. This will usually raise feed water with an initial temperature of 60° to, at least, 100°, where steam pipe and jackets are effectively covered, and if it passes from thence through the feed-water heater, the resulting temperature will be about 150°, and I have found under these conditions that the addition of an economizer will give good results. One combination that works out favorably under the conditions outlined, is to return the condensation to a hot well, carry the exhaust steam from independent auxiliaries to the feed-water heater and extract sufficient heat from the flue gasses going up the chimney, by means of an economizer, to return the water to the boilers at a temperature of from 200° to 225° Fahr. The saving in coal effected by this combination amounts to approximately 15%, with an initial feed water temperature of 60° Fahr. The cost of the complete outfit, hot well, piping, feed-water heater and economizer should not cost in excess of from $8.00 to $10.00 per horse power, and if fuel is costly it can be readily seen that the capital outlay will soon be fully repaid by the saving effected. In this connection it is an excellent plan to fit thermometer wells and thermometers for the purpose of obtaining the temperatures resulting from the various parts of the feed-water system. As previously stated, there are

so many combinations which may be worked out that there is no part of the plant which is worthy of more careful consideration than the feed-water heating system. It is equally true that such study results in a large saving in coal, and it is common to find this element of the pumping station entirely neglected. Cost of coal must also be taken into account when deciding upon the question of the most economical feed-water heating system. The higher the cost of coal, the higher the allowable initial capital outlay for feed-water heating.

Before closing my remarks with relation to the feed water system, it may be well to enumerate the factors to be considered before installing an economizer. They are, briefly:

1. Nature of the auxiliary machinery and the quantity of the heat to be derived from them.
2. The methods of heating the feed water and whether atmospheric heaters are used, and whether all, or part, of the exhaust steam from the plant is used for heating.
3. The initial temperature of the feed water and whether the feed water is taken from hot well or from a cold supply.
4. The probable rise in the temperature due to the installation of the economizer.
5. The cost of the economizer.
6. The cost of the additional building space.
7. The reduction of the boiler heating surface made possible by the economizer.
8. The extra cost of the stack, or forced draft apparatus necessary to compensate for the loss of draft due to the installation of the economizer.
9. Interest, depreciation, maintenance and operating cost, and insurance of all of those elements which are included as a result of installing the economizer.

Steam Piping.—My time is rapidly drawing to a close, and it is possible to refer but briefly to the piping and pipe fittings in the pumping station, although this is a most important element of the design.

In any system of piping, the fundamental object is to conduct the steam from boilers to engines in the shortest, safest and most

economical manner. The material used in the steam pipe system should be the best obtainable and the system should be so flexible that a breakdown in one element will not necessitate the closing down of the entire plant. On the other hand, flexibility increases the number of parts, and unless first cost is of small importance, will materially enhance the initial investment in this portion of the plant. As a general proposition, it is perfectly safe to say that the best pipe and fittings will prove the most economical in the end. It is unfortunate, however, that but few owners of water-works plants are willing to take this view.

Since steam is hotter than the surrounding air, it must lose some of its heat in its passage through the pipe lines. Pipes, therefore, should be of minimum size consistent with not too great pressure losses resulting from the increased friction due to small sizes. If a compromise between loss of pressure and loss of heat could be effected, it would be determined by equating the loss of coal resulting from the loss of a given amount of pressure and a similar loss due to the heat lost through radiation incurred by making the pipe large enough to prevent the loss in pressure. Beyond a small loss in pressure, a further increase in the diameter of pipe affords but little reduction in friction and adds much to the heat radiation losses, so that the use of too large pipes, rather than being economical, may involve increased capital expenditure as well as a reduced efficiency. The chief point to be observed to obtain the maximum duty from the piping is that it shall take the most direct course from boiler to engine, and that boiler and engine should be placed as near together as possible.

Steam piping should never be erected until an assembly drawing of the entire installation, giving the location of all valves and fittings, is prepared, in order to avoid interference and unnecessary bends and fittings. Detailed drawings should also be provided with each division of the piping to facilitate installation, for example:

The high pressure steam system,
The exhaust steam system,
The feed water system,
The suction and discharge lines,
The condensing water system,

and other piping required. Each of those systems should be laid out separately and studied separately, and then brought together as a concrete whole to see that they will not interfere when put together at the station.

Isometric or perspective sketches of the piping usually result in a clearer illustration than the conventional plan and elevation drawing, due, no doubt, to the greater ease with which the drawing is interpreted and on account of the complexity of the piping system as a whole when shown in plan and elevation.

Steam pipes, feed water piping, boiler steam drums, receivers, separators, etc., should be covered with heat insulating material to reduce radiating losses to a minimum. The loss of heat from a bare steam pipe may be taken at about 3 B.t.u. per sq. ft. per hr. per deg. difference in temperature. The actual loss, of course, depends upon many factors—the diameter of the pipe, whether vertical or horizontal, the nature of the surface, the direction and velocity of the surrounding air currents, etc., but by properly applying any good commercial covering, from 75 to 90% of the heat lost by radiation may be prevented.

One of the most difficult problems in steam piping is proper provision for expansion and contraction due to change in temperature, and this difficulty increases with the use of superheated and high pressure steam. Pipes may never be immovably fixed. They should be carried on properly provided rollers and supports which allow free contraction and expansion and the use of long radius bends, and double swing expansion joints, where necessary, will materially aid in preventing breakage and leaks due to an improper provision for expansion.

The need of cooling boilers for cleaning and repairing, as well as the fact that some boilers or engines may be idle and cold, while others are hot, causes the connecting pipes, between the boilers or engine and the main header, to vary in length, not only as a result of their individual contraction and expansion, but also due to the change in relative length between one boiler or engine and the others. Between a temperature of 60° Fahr., and the temperature of steam at 200 lb. pressure, the expansion in a pipe will be over 4 in. in 100 ft. A good, practical rule to follow is to allow for 1 in. expansion in every 50 ft. of pipe. With superheated steam, the

expansion will be even greater than mentioned. Obviously, therefore, such variations must be provided for.

Unfortunately, the cause of the greater part of inferior station pipe work can be traced directly to the engineers. There is no other portion of station work that affords the engineer a similar opportunity of showing his knowledge of station requirements, none that requires as much time to properly design, and none that is more certain to develop the station into a run-down, expensive plant, or the reverse. The piping and pipe system are the chief features of a pumping station design that really require engineering knowledge. The pumping engines, as a rule, are designed by the builders for given capacities, and if the piping and pipe system are not properly cared for by the engineer, he fails to do that work which is purely his and the result is very serious to the station duty of the plant.

In closing, I desire to lay special stress upon the fact that every element of design with regard to pumping stations has not only its engineering side, but chiefly, and more important, the economic side. There is no detail of a station which cannot be taken up from the economic viewpoint with advantage to the engineer's clients, or to the municipality which the engineer serves, and until every element of a pumping station is considered in this light, we are not going to get the stations which produce water at the lowest total cost.

DISCUSSION.

KENNETH ALLEN, M. M. E. N. Y.—In the selection of the proper type of pump, errors of judgment are often made. The writer has in mind an expensive quadruple expansion pump which, while it showed a test duty which was at that time the record, was so difficult to keep in proper alignment and so costly to operate, that it was dismantled and replaced by a machine giving a lower duty, after a brief term of service.

The simplicity, compactness and low first cost of the centrifugal pump is enlarging its field of usefulness in permanent as well as temporary installations. On account of its speed it is particularly adapted to operation by electric motors or turbines—steam or water. Where fuel gas is cheap, the internal combustion engine geared to triplex or other reciprocating pumps is often a favorable combination, particularly in the case of high lifts and moderate volumes. With very low lifts and large volumes pumps of the propeller type, such as that recently installed for flushing the Gowanus Canal, are usually to be preferred, while for very low lifts and relatively small volumes, ejectors using air expansively have decided merits, especially for raising sewage or other liquids containing coarse suspended matter. Again, where the head is quite constant and there are several units to be operated simultaneously, the air-lift should be considered, provided other conditions, such as submergence of the air jet, are favorable.

In planning pumping plants, it is often a question which of the several types of pump mentioned should be specified. In fact it is sometimes a matter that can only be decided after calling for alternate bids, in which a specified duty is guaranteed. In the case of a pumping plant to operate a group of artesian wells, the writer once called for competitive bids based upon operation by air lift, by a centrifugal pump direct-connected to an electric motor and to a similar pump actuated by an impulse wheel taking water from a neighboring force main.

A six-hour test after six days' continuous operation of the wells was specified at full capacity and lift, and then at two-thirds capacity and two-thirds full lift, and a resultant duty was determined by taking seven-tenths the duty obtained in the first test and three-tenths that in the second, based upon the dry steam used, including that used for jackets and vacuum pumps, but crediting that used in feed-water heaters.

Under bids tendered on the foregoing basis the contract, owing partly to the local conditions, was awarded for the air lift plant. By the insertion of a bonus and rebate clause in the contract the final payment, after making the test, was a trifle less than the price bid.

Probably no great increase in the test duty of the usual types of pumping engines, if well designed, can be looked for, but in the matter of station duty there is a wide field for increased economy in the majority of plants. Perhaps the most salient points in Mr. Hill's paper is that true economy depends on various factors, of which the duty based on steam consumption is but one; and that the usual test duty is merely an index of this.

It has too frequently been the case that, after a satisfactory test on installation, pumping plants have been complacently allowed to operate for years without any true check on the ordinary station duty. The writer has in mind one large city in which it was discovered, after many years' service, that the slip in a large number of the pumps was 30 or 40 per cent. Such instances are not rare.

Slip is a matter so often undiscovered, so important and so easily detected that there is no excuse for the waterworks superintendent to be ignorant regarding the condition of his pumps in this respect. A Venturi meter on the discharge and a counter on the engine are most convenient and all that is necessary for this determination. A comparison of the volumes pumped, as indicated by each, gives the information desired.

Aside from the plant itself, station duty depends to a considerable degree on the personnel and experience of the engineers and firemen. In a duty test the greatest care is given to the stoking. If this is done by hand the annual loss incurred by inefficient employees may be large. A certain check on the firing may be had by comparing the amount of steam furnished (indicated by a meter placed on the feed-water line) with the weight of coal burned.

Losses by condensers leaking or by draft regulators, or other automatic appliances that do not work properly, should be guarded against. In many stations the bin capacity is inadequate, the coal is stored exposed to the weather for long periods and so deteriorates, resulting in higher operating costs.

Machinery lying idle on account of excessive capacity, as occasions when, on account of repairs, less efficient machinery has to be put in service, is another frequent source of loss.

In short, in planning a pumping plant, the year-in and year-out costs for wages, coal, supplies and repairs should all be taken into account before coming to a final decision on the type and duty of the pumps required.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

ADDRESS OF HENRY W. VOGEL, PRESIDENT OF THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Presented at the Annual Meeting of the Society on January 24th, 1912.

We have lived long enough as a Society to have memories of the past, to enjoy the experiences of the present and to look hopefully and cheerfully to the future.

The success we have attained is undoubtedly largely due to the active interest manifested in the welfare of the Society by the Officers, the members of the Board of Directors and the Chairmen and members of the Committees. The large and growing attendance at our monthly meetings is an indication that our members are anxious to give time and thought to professional work that is not always connected with their daily routine duties.

Our Society may be said to be mechanically efficient, we have systematized and standardized, but if we stop there we shall fossilize; we must, to a certain extent, idealize. The idealist is the creator of progress. Nine or ten years ago, Mr. Lindenthal, then the Bridge Commissioner, had plans prepared for numerous public buildings in the neighborhood of City Hall Park by Mr. Hornbostel, the architect. The plans at that time seemed fanciful; to-day a new municipal building is approaching completion, and a Court-House site and a "Civic Centre" definitely established, all on a larger scale than the proposals of Mr. Lindenthal.

We shall never be confused if we look far enough ahead, remembering that we are public servants and not victims of the City's prosperity.

Meetings.

The attendance at our meetings has increased over former years, the maximum, minimum and average, exclusive of the annual meeting, being respectively 207, 98 and 148.

At the annual meeting the House Committee entertained the members and their friends with a "Smoker" at which 307 were present. This number added to the attendance at the eight regular meetings makes a total of 1 492 for nine meetings, an average of 166.

The papers presented during the year dealt with the geology of New York City, the methods of interpreting the elevations of all portions of a street surface from established grades, sanitary problems of the Board of Water Supply, the construction of the Rondout pressure tunnel, the City plan, the contractor's view of City contracts and specifications, the port of New York and waterworks pumping stations. The papers were instructive, developed interesting discussions, and will form valuable additions to the literature of our Society. The Publication and Library Committee has arranged for five of the eight papers to be read in 1912.

MEMBERSHIP.

We have added to our numerical strength during the year, although three of our members died, fourteen resigned and twenty-three were dropped from the rolls for neglecting their financial obligations to the Society. Sixty-one of the sixty-five men elected, became members of the Society by the payment of dues. The number of members enrolled at the beginning and end of the year is 513 and 534, respectively. The increase in membership is partly due to the establishment of a non-resident class of members, consisting of municipal engineers who are employed on engineering work pertaining to and distant more than twenty-five miles from New York City.

FINANCES.

The budget estimates of the receipts and expenditures for the year 1911 were $6 000 and $5 798 respectively, the actual receipts and expenditures were $6 086 and $5 189 respectively. The decrease in expenditures below the estimated amount is mainly due to giving up early in the year the smaller of the two rooms which formed our quarters in the Engineering Societies Building.

A new agreement was entered into with reference to the advertisements for the 1911 *Proceedings*. It is hoped that the revenue derived from this source will make the publication self-supporting.

Quarters.

Early in the year the Board of Directors decided to relinquish the smaller of the two rooms, which constituted our comfortable and well-furnished quarters. The members have access to our quarters and valuable library at all times, yet the use made of them did not warrant the expense of maintaining the two rooms. The rental saved has placed us on a good financial basis. The curtailment of space has caused no inconvenience to the Society.

Inspections.

Interesting inspection trips were made to the Astoria Plant of the Consolidated Gas Company, the Public Library Building of the City of New York, the New York Botanical Garden, Dry Dock No. 4 in the U. S. Navy Yard, in Brooklyn, and the Bush Terminal. The five inspections together were attended by 585 members and their friends.

It is believed that the interest in future inspection trips and the attendance can be greatly increased if the announcement notice to the members contains a printed description of the proposed inspection, and if the first announcement is followed by a reminding notice.

Special Committees.

Two bills were introduced in the Legislature providing for the issue of a license to Engineers to practice in this State. Your special committee was heard before the Committee on Laws and Legislation at Albany with reference to one of the bills, which embodied, with some alterations, the provisions of the bill drafted by the Board of Direction of the American Society of Civil Engineers. Neither of the bills became a law.

The special committee in the matter of securing suitable quarters in the new municipal building has been in correspondence with the Board of Estimate and Apportionment and the Sinking Fund Commissioners. It is probable that a room can be secured for our monthly meetings, but it is not at all likely that permanent quarters can be obtained.

ANNUAL DINNER.

The great social reunion of our organization was, as usual, our annual dinner. That both guests and members thoroughly enjoyed the occasion was evidenced by the fact that no one left the gathering until the last word was spoken. The occasion left "a pleasant taste in the mouth, and a happy thought in the mind."

BOARD OF ESTIMATE AND APPORTIONMENT.

The routine work accomplished by the Board of Estimate and Apportionment during the year is shown by the following tables:

CORPORATE STOCK ISSUES.

(Approximately correct.)

Improvement.	Amount Authorized.
School sites and buildings	$12 549 718.99
Improvement of water supply	10 221 695.32
Land for terminal at Brooklyn Bridge and for Municipal Building	1 880 000.00
Bridge construction	2 811 000.00
Land for Bridges	3 508 856.63
Repaving, street improvements, and asphalt plant	5 185 900.00
Fire Department	1 878 805.26
Street and Park Opening Fund	8 261 976.16
Health Department and Department of Charities—Hospitals	9 222 380.66
Subways and Rapid Transit	25 846 084.55
Public Libraries	678 549.32
Docks and Ferries	9 074 901.29
Park, parkway, and playground improvements	6 477 582.68
Sewer improvements	146 115.00
Topographical work	569 300.00
Concourse—transverse roads	280 000.00
Police stations, court-house and prison	1 601 875.00
Swimming pools, public baths, and bath house at Coney Island	875 000.00
Change of Grade Damage Commission	798 341.40
Public buildings	684 000.00
Uncollectable taxes	5 000 000.00
Metropolitan Sewerage Commission	34 000.00
Street cleaning	385 785.26
	$107 421 817.52

ASSESSABLE IMPROVEMENTS AUTHORIZED.

Borough.	Grading and Paving Improvements.		Sewer Improvements.		Total.	
	No.	Amount.	No.	Amount.	No.	Amount.
Manhattan	31	$430 000.00	16	$121 000.00	47	$551 000.00
Brooklyn	310	1 956 000.00	150	881 400.00	460	2 837 400.00
The Bronx	80	1 486 400.00	39	792 400.00	119	2 278 800.00
Queens	36	482 800.00	35	457 900.00	71	940 700.00
Richmond	10	34 000.00	8	203 600.00	18	237 600.00
Total	467	$4 389 200.00	248	$2 456 300.00	715	$6 845 500.00

STREET AND PARK OPENING PROCEEDINGS AUTHORIZED.

Borough.	Number of Proceedings.	Number of streets and parks affected.
Manhattan	7	16
Brooklyn	38	66
The Bronx	22	37
Queens	38	72
Richmond	9	10
Total	114	201

In addition to the above, the Presidents of the various boroughs were authorized to prepare plans and specifications for 126 surface and sub-surface assessable improvements estimated to cost $2 791 100, with the understanding that as soon as this preliminary work had been completed a final authorization would be given.

Final maps laying out a street system for about 6 500 acres were adopted during the year and tentative maps have also been approved showing the treatment contemplated for an additional area of about 5 300 acres. Drainage plans for about 7 900 acres were approved.

BUDGET FOR 1912.

The budget for the year 1912, adopted at the close of October in accordance with the Charter requirements, and as subsequently amended, shows the following apportionment of funds to be raised in the tax levy of next year:

Mayoralty	$213 808.00
Board of Aldermen	285 810.00
Law Department	788 410.00
Department of Finance	1 483 690.00
Department of Bridges	825 312.25
Department of Docks and Ferries	2 959 623.62
Department of Water Supply, Gas and Electricity	7 375 146.85
Department of Street Cleaning	7 421 687.67
Department of Parks	3 513 598.62
President, Borough of Manhattan	2 676 192.71
President, Borough of Brooklyn	2 228 793.10
President, Borough of The Bronx	1 128 332.19
President, Borough of Queens	1 748 983.71

President, Borough of Richmond......	$787 200.00
Tenement House Department.........	806 327.00
Department of Health................	3 142 417.00
Education	34 956 846.28
Police Department..................	16 039 781.70
Fire Department....................	8 537 365.55
Public Libraries....................	1 191 033.47
Department of Taxes and Assessments.	589 975.00
Courts (City, Municipal, City Magistrates and Special Sessions)......	2 275.090.00
Rent	1 389 228.91
Department of Bellevue and Allied Hospitals, Department of Correction, Department of Charities, Board of Ambulance Service, Coroners, and Charitable Institutions...........	10 689 503.38
Board of Estimate and Apportionment, Board of Assessors, Permanent Census Board, Armory Board, Commissioners of Accounts, Commissioner of Licenses, Board of Elections, Board of City Record, Examining Board of Plumbers, Civil Service, and miscellaneous........	3 312 560.00
County Charges	10 223 103.98
Debt Service.......................	54 541 894.91
Total	$181 131 715.90

Areas of Assessment.

The legislation providing for assessing large areas for benefit to which reference was made in last year's review, was obtained during the year through the provisions of Chapter 679, which is generally known as the Gerhardt Bill. The act has been applied, however, only in the case of acquiring title to the Queens Boulevard.

Precise Levels.

The field work in connection with the establishment of a system of standard primary bench marks in New York City has been practically completed.

The geographic position of a point in front of the New York Public Library was determined, and a true meridian laid down through the point. It is proposed to mark this point permanently with a suitable design indicating its geographic position, also the direction of the true and magnetic meridians.

DEPARTMENT OF TAXES AND ASSESSMENTS.

Maps were prepared showing the assessed value per front foot of normal lots having a depth of 100 feet for the year 1911, following a plan inaugurated two years ago. The maps show every block frontage within the City limits and were published by the Record and Guide Co., as Section Two of the *Real Estate Record and Guide,* dated September 16th, 1911.

New tentative tax maps of the Borough of The Bronx, east of the Bronx River, showing the new street system as far as it has been officially approved by the Board of Estimate and Apportionment, were in progress during the year.

The records show that the assessed valuation of taxable property for the year 1911 is $8 216 763 287, while that of property exempt from taxation is $1 576 208 879, making a total of $9 792 972 166.

PUBLIC SERVICE COMMISSION.

Construction Work.

The work on the Subway now in operation consisted of providing additional facilities at the stations in the boroughs of Manhattan, The Bronx and Brooklyn, and completing and opening to the public the station at One Hundred and Ninety-first Street.

Borough of Manhattan.

Work was resumed on the incomplete section of the Brooklyn Loop line at and near the Municipal Building, Chambers and Centre Streets.

New construction work on the Lexington Avenue Route was begun on the following sections: Section 6, extending from Twenty-sixth to Fortieth Street; Section 8, extending from Fifty-third to Sixty-seventh Street; Section 10, extending from Seventy-ninth to Ninety-third Street; Section 11, extending from Ninety-third to One Hundred and Sixth Street; Section 12, extending from One

Hundred and Sixth to One Hundred and Eighteenth Street. The Contractor's plant is being assembled on Section 13, extending from One Hundred and Eighteenth Street to One Hundred and Twenty-ninth Street.

Borough of The Bronx.

Plant is being assembled preparatory to beginning active construction work on Section 15 of the Lexington Avenue Route, which extends along Mott Avenue from Park Avenue to River Avenue, and along One Hundred and Thirty-eighth Street from Park Avenue to Alexander Avenue.

Borough of Brooklyn.

Fourth Avenue Route.—The construction work on the section extending along Flatbush Avenue Extension, from Nassau Street to Willoughby Street, is 80% completed; on the section extending along Flatbush Avenue Extension and Fulton Street, from Willoughby Street to Ashland Place, 61% completed; on the section extending along Ashland Place and Fourth Avenue, from Fulton Street to Sackett Street, 68% completed; on the section extending along Fourth Avenue, from Sackett Street to Tenth Street, 90% completed; on the section extending along Fourth Avenue from Tenth Street to Twenty-seventh Street, 91% completed; and on the section extending along Fourth Avenue from Twenty-seventh Street to Forty-third Street, 91% completed.

Division of Designs.

Plans were prepared for additional facilities at the stations of the Subway now in operation.

The plans of the Broadway-Lexington Avenue Subway were changed because of reduced head room and alterations at the stations.

Studies and plans were made for proposed extensions and new routes.

Borings for New Routes.

Borings are being made in the following localities:

Manhattan.—Seventh Avenue, from Fourteenth to Fifty-ninth Street; Fifty-ninth Street, from Seventh Avenue to Second Avenue;

Sixtieth Street, from Fifth Avenue to Second Avenue; and Broadway from Fourteenth Street, to Times Square.

Brooklyn.—East Ninety-eighth Street, Livonia Avenue, Nostrand Avenue, Stuyvesant Avenue and Utica Avenue.

Across the East River.—Between Atlantic Avenue and the Battery and between Pineapple Street and Old Slip.

BOARD OF WATER SUPPLY.

During 1911 construction work was prosecuted actively on 34 main contracts for the Ashokan impounding, the Kensico storage and the Hill View equalizing reservoirs, on the 110 miles of transportation works between the Ashokan Reservoir and the terminal shafts in Brooklyn, and 9 miles of pipe line in Brooklyn and Queens. Seven of these contracts, amounting to $22 000 000, were awarded during the year, making the aggregate amount of contracts awarded about $91 000 000, upon which about $18 000 000 was earned during the year, making a total of about $42 000 000 earned to date.

An aggregate depth of 4 220 ft. of shaft was sunk during the year, making a total of 14 440 ft. (2.7 mi.) to date.

The excavation of full grade and pressure tunnel was 48 134 ft. (9.1 mi.) for the year, with a total to date of 156 644 ft. (29.7 mi.). *Thirty-five and a half miles of full aqueduct section was cast of concrete during the year,* of which 124 076 ft. (23.5 mi.) was cut-and-cover aqueduct and 63 353 ft. (12.0 mi.) pressure and grade tunnel. To date there is a total of 55 miles of waterway section concreted, of which 40 miles are cut-and-cover and 15 miles in tunnel. Construction was started about July 1st on the 24 shafts of the deep pressure tunnel in the City. The excavation of the tunnel proper has been started from five of these shafts.

At the Hudson River Crossing the Board's forces sunk the East and West shafts to their final depth and turned the tunnel headings at a depth of about 1 100 ft. below the river level. Early in the year a contract was prepared for the completion of this siphon; of the 3 020 ft. of tunnel under the river, there remains only 350 ft. to be taken out.

The last concrete block on the main masonry section of the Olive Bridge dam at the Ashokan Reservoir was set on November 2nd.

Surface and sub-surface location surveys are under way for pipe lines to Queens and Richmond and for Silver Lake Reservoir on Staten Island.

The total force in the Engineering Bureau of the Board of Water Supply, numbering 1 059 on December 27th, consisted of 299 engineers, 439 engineering assistants and inspectors, 148 clerks and 173 gagekeepers and laborers.

The maximum daily contractors' force actually at work in the field on one day exceeded 16 200, while the minimum was about 7 500. This does not include men in the contractors' camps temporarily idle, nor those engaged indirectly on the work in mills, factories, repair-shops, etc.

DEPARTMENT OF WATER SUPPLY, GAS & ELECTRICITY.

(Work on Extension and Improvements of Water Supply.)

BOROUGHS OF MANHATTAN AND THE BRONX.

During the year 1911, a serious shortage of water supply for these boroughs was threatened owing to the extremely low rainfall during the past two years. The rainfall for the twelve months ending June 30th, 1911, was 36½ in., the lowest experienced in forty-three years. The means adopted to avert a shortage of supply were the detection and stoppage of leakage from the mains by pitometer measurement, and the appointment of a special corp of inspectors to make a house to house inspection to see that the plumbing was in good condition. The inspectors commenced their work in June, and the consumption was reduced from about 335 million gallons per day to 275 million gallons per day, or a reduction of nearly 20 per cent. To further safeguard the supply, complete surveys, plans, specifications and contracts were prepared for a temporary supply from the Ten Mile River, this supply being equivalent to 50 million gallons per day, at an estimated cost of $1 200 000.

The heavy rains in the late summer and fall eliminated the danger of shortage in the supply, and plans for the temporary supply from the Ten Mile River were abandoned.

The filtration of the Croton water, which had been urged by this Department for several years, has been authorized. On June

20th, 1911, the Board of Aldermen adopted a resolution for a bond issue of \$8 690 000 to carry out the work, and plans are now in preparation.

Improvements have been made at the pumping stations at Ninety-eighth Street, at One Hundred and Seventy-ninth Street, at High Bridge and at Jerome Avenue.

In the Distribution System, about 25 miles of mains have been laid, and 8 miles removed or abandoned, making the total length to date about 1 300 miles. About 1 400 valves and 1 800 hydrants have been set. In this connection it should be stated that the Department is carrying out the plan of replacing all old hydrants of less than 600 gallons per minute capacity with larger and more modern types, and of eliminating 6-in. water mains; 8-in. mains being the smallest size to be laid hereafter. Numerous complexities now existing in the system, due to the paralleling of small and large mains, are gradually being eliminated by the removal of small mains and the transference of taps to large mains.

At several places in the southerly part of The Bronx, where trunk mains are at present interrupted by railroad, canal and river crossings, borings have been made to determine the best means of connecting the mains. Probably tunnels may be required in some cases. The connections when made will result in increased pressure and flow in the low service in the Westchester and lower Bronx districts and the upper Manhattan low service north of Central Park.

Extensions to the High Pressure Fire Service System, covering an area of 800 acres and representing an increase of 56% over the area previously protected, have been put into service. The boundaries of the present protected areas are as follows: Twenty-third Street to Chambers Street west of Third Avenue, and Houston Street to Maiden Lane east of Third Avenue and Nassau Street. Plans are under way for the extension of the High Pressure System to cover the entire remaining area of lower Manhattan, south of the existing system.

A modern building to cost about \$47 000, for storage, garage, stable and offices, is being constructed in the Department yard, at Twenty-fourth Street and Avenue A.

Borough of Brooklyn.

The new addition to the Ridgewood Pumping Station has been practically completed; also the new pumping plants, consisting of four pumping engines having a total capacity of 76 million gallons daily; 8 Heine Water-Tube Boilers, equipped with mechanical stokers and an economizer, making a thoroughly modern plant, and giving ample capacity and equipment for the work required, thus relieving the critical situation previously existing.

Contracts have recently been let for the general improvement of the buildings and grounds of the numerous line stations in the watershed. Twenty-one wagon, 6 railroad, and 8 wheelbarrow coal-weighing scales have been erected at the line stations, thus giving facilities for the proper checking of coal deliveries.

In the Distribution System about 26 miles of mains have been laid, making the total length to date 970 miles. About 2 100 valves and 1 800 hydrants have been set. The extension to the High Pressure Fire Service System, started during last year, has been completed. The area protected by this extension is about 1 200 acres, or an increase over the area previously protected of 75 per cent. The total area protected in the main system is about 2 600 acres, the boundaries being from East River to Sixth Avenue and Courtland Place, and from Fortieth Street to the Navy Yard. There is also an area of about 250 acres in the Coney Island Amusement District protected by an independent High Pressure Fire Service.

Borough of Queens.

In the Third Ward, at Bayside, two new 4 million gallon pumping engines have been put into service and new wells have been driven, thus furnishing an additional supply nearly sufficient to eliminate the purchase of water for this Ward from the Citizens Water Supply Company, which heretofore has amounted to an average of 1.1 million gallons daily, and also to permit the temporary shutting down of the Whitestone Pumping Station, pending improvements there, while at the same time the pressures have been improved.

At Whitestone, new wells and suction mains have been laid, the erection of a new pumping station has been under way and is approaching completion. A 2 million gallon pump has been brought

from the Bayside Station and set up, and an additional pump and two boilers contracted for are under construction at the maker's works.

In the Distribution System, about 10 miles of pipe have been laid, making the total length to date about 180 miles. Four hundred valves and 130 hydrants have been set.

Borough of Richmond.

Contracts have been let for new wells and a new pumping station in the vicinity of Grant City, on the Southfield Boulevard, as a part of the plan for increasing the supply by about 5 million gallons per day, or about 50% of the present supply. The station building is nearly completed and about 60% of the work on the wells is finished. Other features of the general scheme have been delayed on account of legal difficulties in connection with the acquisition of the necessary land. It is expected, however, to have this work under way during the coming year.

In the Distribution System, 19 miles of mains have been laid, making a total length to date of about 200 miles. Included in this is a trunk main about 13 miles in length along the South Shore from Tompkinsville to Eltingville. About 500 valves and 250 hydrants have been set.

DEPARTMENT OF DOCKS AND FERRIES.

The activities of the Department of Docks and Ferries during the year 1911 embrace the work of the Engineering Bureau, the Bureau of Dock Superintendence, the Ferry Bureau and the Bureau of Mechanical Repairs.

The Bureau of Dock Superintendence, in addition to its conservation of all matters affecting wharfage interests, has kept open bulkheads and piers properly cleaned. Some idea may be formed of the magnitude of this work by the fact that 72 piers and 72 bulkheads, with the marginal street in the rear, are devoted to public wharfage.

The work done in connection with the Ferry Bureau, outside of the operation of the municipal ferries, has required an expenditure of about $350 000, including the cost of changing the construction of the South Brooklyn ferryboats, the entire lower

deck being devoted to team traffic and the upper deck to passenger service.

The Bureau of Mechanical Repairs, which was inaugurated and established during the year 1910, has brought about rapid and satisfactory repairs to the ferryboats and floating plant of the Department. With ten municipal ferryboats in service, the necessity for constant repairs is obvious.

The Engineering Bureau originates and executes the improvements affecting the use of the waterfront and the maintenance of existing structures.

BULKHEAD WALL.

This work has comprised during the past year the progress or completion of the sea-wall on the James Slip, Jefferson and Corlears Sections on the lower East River; the Yorkville and Blackwell Sections on the upper East River; the East One Hundred and Twenty-third Street Section on the Harlem River, and the Gowanus and Whale Creek Sections in Brooklyn, aggregating 1 047 lin. ft. of bulkhead wall construction.

The Department has also supervised the construction of bulkhead or sea-wall on the Montgomery Section, lower East River, by the New York, New Haven and Hartford Railroad Company, and a section of wall in the vicinity of Cortlandt Street, built by the Pennsylvania Railroad Company.

The work at Riker's Island, comprising the construction of a rip-rap and dry stone embankment wall for the retention of street sweepings by the Department of Street Cleaning, has been completed by the Department of Correction under the supervision of the Department of Docks and Ferries.

An extensive improvement along the waterfront, between West Seventy-second and West One Hundred and Twenty-ninth Streets, North River, involving subsequent extension of Riverside Park out into the river as far as the bulkhead line established in 1868, was begun by the Department of Docks and Ferries, by dredging preliminary to the depositing of a rip-rap embankment for the retention of filling outshore of the New York Central and Hudson River Railroad Company's embankment; the material for the new rip-rap embankment is taken from the shafts and headings for the high-pressure water tunnel on Manhattan Island.

The construction of the sea wall has left an area in the rear which has been filled in to the extent of 375 000 sq. ft. in order to produce the marginal street. Grading and paving of these filled-in areas has been completed between West One Hundred and Twenty-ninth and West One Hundred and Thirty-fourth Streets on the Claremont section, at the James Slip, Jefferson and Stanton Street sections on the lower East River, and is in progress at the present time on the Yorkville and Blackwell sections as well as at the Gowanus and Whale Creek sections in Brooklyn.

Piers.

The southerly pier at Gansevoort Market on the North River, the Pier No. 42 near Gouverneur Street on the East River, the Tiffany Street pier in The Bronx, the pier at the foot of Gold Street, East River, Brooklyn, and the pier at Whale Creek, Brooklyn, have been built during 1911; in all five new piers.

A new pier is in progress of construction at the foot of West Ninety-fifth Street, North River. Five piers on the North River have been extended to the latest established pierhead line.

In addition to the foregoing, the berthing of the *Olympic* has required a temporary extension of Piers 58 and 59 on the Chelsea section, 100 ft. beyond the established pierhead line. This necessitated a special permit from the War Department.

Freight sheds have either been completed or are in advanced state of progress at One Hundred and Twenty-ninth Street, North River, and at Thirty-third Street, South Brooklyn.

Asphalt pavement has been laid on the reinforced concrete decks of six piers, namely, Piers 5 and 6, East River; East Fifth Street, East Ninety-fifth Street, East One Hundredth Street, and on the pier at Fifty-first Street, South Brooklyn.

Ferries.

The ferries of the Brooklyn Ferry Company of New York at the foot of Roosevelt Street, East Twenty-third Street, and at Broadway, Brooklyn, which have not been in operation for some time, were leased to the Brooklyn & Manhattan Ferry Company on terms that required the City to restore the terminals, which have been practically rebuilt and placed in commission during the year, and

are now being operated by the Brooklyn & Manhattan Ferry Company.

New Wharfage.

9 000 lin. ft. of new wharfage have been created, and 7 300 lin. ft. of old wharfage room have been destroyed. The superficial area of the City's new-made land has been increased by 375 000 sq. ft.

New Plans.

Studies and plans are now in progress for thousand-foot piers at Ganesvoort Market, and at the section between West Forty-fourth and West Fiftieth Streets.

Extensive studies and plans for comprehensive development with freight and warehouse terminals are in progress for the section between Oak Point and Fort Schuyler, Eastchester Creek, Flushing Bay, Nott Avenue in the Borough of Queens, the vicinity of the Erie Basin, the easterly shore of Staten Island, and at Fresh Kills. Staten Island, comprising numerous piers, slips and basins.

Plans are well progressed also for a freight elevated railroad to extend from West Sixtieth to Cortlandt Street, for use in connection with freight warehouse terminals which the Department proposes to establish at points along the easterly side of West Street, for relieving the piers on the North River waterfront from railroad use and diverting them to their more legitimate functions for marine commerce.

The plan for the development of Jamaica Bay is now before the Commissioners of the Sinking Fund, and forms of contracts with plans and specifications are ready at the present time for the commencement of actual work.

DEPARTMENT OF BRIDGES.

Brooklyn Bridge.

Plans have been prepared for the reconstruction of the Manhattan Terminal, which provide for a new building to replace the present train shed, a rearrangement of the tracks, a connection with the subway in the basement of the new municipal building, and replacing the extension of the train shed over Park Row with an elevated promenade from City Hall Park to the Building. The new

building will have an ornamental front harmonizing with the new Municipal Building.

Manhattan Bridge.

The track work and electrical equipment on the lower deck have been completed, movable platforms for use in inspecting and painting the under portion of the suspender spans have been erected, and a fire protection system, consisting of pipe lines, stand pipes and hose connections, has been installed. A contract amounting to $134 500 has been let for constructing the westerly subway and Bayard Street retaining wall at the Manhattan Plaza, and the work is about 25% completed. Plans for the improvements on the plazas have been developed preparatory to letting contracts for this work.

Williamsburgh Bridge.

A contract amounting to $559 540 has been let for strengthening the end spans, and this work is now in progress. The work consists in building new intermediate shore towers, sub-dividing and reinforcing the shore spans, and changing and reinforcing the lateral system of these spans. This work, in connection with the reinforcement of some members of the main span trusses, will greatly increase the live load capacity of the structure, and will permit a more satisfactory development of the rapid transit system in connection with this structure.

Additional feeder cables have been installed on the northerly pair of surface tracks.

Queensboro Bridge.

A contract for the police shelters and certain electrical work has been completed.

A contract amounting to $182 300 for the installation of the electrical equipment of the conduit tracks and the construction of the track extension on the Plaza has practically been completed, thus providing for the accommodation of the surface cars of the Third Avenue Bridge Company, this Company having been granted a franchise to operate over the bridge.

Eastchester Temporary Bridge.

A temporary bridge has been built at this location in order to carry the traffic across the Hutchinson River while the old structure is being removed and replaced with a new one.

Pelham Bridge.

Four shelter houses and ornamental towers have been built on the channel piers of the bridge, thus completing the new structure, and the old bridge is now being removed.

Harlem River Bridges.

Four shelters for pedestrians have been constructed on each of the following bridges over the Harlem River: Willis Avenue Bridge, Third Avenue Bridge, One Hundred and Forty-fifth Street Bridge, Macomb's Dam Bridge and Ship Canal Bridge. The total cost of these shelters amounted to $14 150.

Vernon Avenue Bridge.

Four shelters for pedestrians have been constructed on the bridge over Newtown Creek at this location, at a cost of $4 614.

Municipal Building.

Satisfactory progress has been made on the erection of the superstructure of this building. The steel framework, weighing 26 000 tons, has been completed within two days of the schedule for erection. Floor slabs have all been completed, the granite shell, amounting to 700 000 cu. ft., has all been cut, and is now set to the eighteenth floor. Bids are now advertised for the installation of elevators, and plans and specifications are now prepared for the interior finish of the building.

General.

The engineering branch of the Department has been reorganized into the following divisions: Division of Design, Division of Construction, Division of East River Bridges, Division of Harlem River and the Bronx, Division of Brooklyn, Queens and Richmond, Division of Shops and Stores. The last four divisions are occupied with the maintenance of the bridges.

INTERSTATE BRIDGE.

The investigations of the New York and New Jersey Interstate Bridge Commission have been at a stand-still during the past year, owing to the failure of the New Jersey Legislature to appoint members of the Commission from their State.

It is hoped that the New Jersey Legislature will appoint a new Commission in the early part of 1912, when the work will be again pushed forward.

DEPARTMENT OF PARKS.

Borough of Manhattan.

The construction of the southerly portion of Colonial Park, the construction of the chain of parks in Broadway, between One Hundred and Tenth and One Hundred and Twenty-second Streets, and the regulating and grading of John Jay Park and the new street on its westerly side have been completed.

A pipe sewer, 542 ft. in length, was laid from the Storage Yards at Ninety-seventh Street, Central Park, to the City sewer.

5 000 sq. yds. of experimental pavements were laid in various sections of Central Park.

A large playground in Columbus (Mulberry Bend) Park, a small playground at the intersection of Worth and Baxter Streets, a playground between Fifty-ninth and Sixtieth Streets, west of Amsterdam Avenue, a playground in St. Gabriel's Park, between Thirty-fifty and Thirty-sixth Streets, First and Second Avenues, and a playground in Cherry Street, adjacent to the Bridge, were completed. Temporary playgrounds were also constructed in Highbridge Park, and on Amsterdam Avenue between One Hundred and Fifty-first and One Hundred and Fifty-second Streets. Work on two large playgrounds, the one, between Fifty-ninth and Sixtieth Streets, east of Sutton Place, under the Queensboro Bridge, and the other at One Hundred and First Street, between Second and Third Avenues, was begun during 1911, but not completed.

Borough of Richmond.

11 000 sq. ft. of cement walk pavement and 2 220 lin. ft. of cement curb were laid on the Richmond Turnpike sidewalk of Silver Lake Park.

Borough of The Bronx.

Work Completed.—New paths and drains constructed in St. Mary's Park; grading Echo Park; new tree plantations in Crotona Park; extension of system of bridle paths; removing concrete and

setting granite coping on fountain in Colonial Garden; resurfacing Two Hundred and Forty-second Street from Broadway to New York and Putnam Railroad, Mosholu Avenue from Broadway to Jerome Avenue, and Grand Avenue from the Golf Links to Jerome Avenue; draining swamp lands and enlarging lake in Van Cortlandt Park; swamp lands drained and the Golf Course completed in Pelham Bay Park; a new road to connect the Botanical Garden with Bronx Park East; the Sunken Garden; new greenhouses; additional Bear Dens in the Zoological Garden and the bridge over the falls in Bronx Park.

In Pelham Parkway from Williamsbridge Road to White Plains Road the roadway was reconstructed and resurfaced with asphaltic mixture, on the southerly roadway the grading was completed and a pavement of asphalt block laid between White Plains Road and the bridge over the New York, New Haven and Hartford Railroad. the roadway was also resurfaced between White Plains Road and the Southern Boulevard.

A road was built connecting the Mosholu Parkway with the Grand Boulevard and Concourse.

Work in Progress.—Installing electric power equipment in workshops in Bronx Park; rebuilding and widening City Island Road from Bartow Station to City Island Bridge; completing brick drain and constructing inlet basin, and improving rock cut at Broadway and Two Hundred and Fifty-third Street in Van Cortlandt Park; erecting a reinforced concrete bridge from Hunter to Twin Island in Pelham Bay Park.

BOROUGHS OF BROOKLYN AND QUEENS.

Work Completed.—The bridge over the Shore Road at First Avenue; the new playground adjoining Red Hook Park, wrought-iron picket fences around Bushwick Park, Fulton Park and Amersfort Park in Brooklyn, and Kings Park in Queens; bluestone coping with bronze railing around Borough Hall, 51 000 sq. ft. of new asphalt tile walk in Prospect Park; the Speedway of the Ocean Parkway resurfaced with loam; New pavement, including curb and brick gutter, on Forest Parkway from Jamaica Avenue to Forest Park.

Work in Progress.—McCarren Playground, bounded by Driggs Avenue, North Twelfth Street, Bedford Avenue and Lorimer Street;

playground at Putnam and Knickerbocker Avenues; the Shore Road improvement, 2 000 lin. ft. of concrete and granite sea wall finished; the foundation for the Brooklyn Museum of Arts and Sciences on the Eastern Parkway; plans for the improvement of Highland Park, Dyker Beach Park, the triangle at Pitkin Avenue and East New York Avenue, for the completion of Sunset Park, and the remodeling of Fort Greene Park.

CITY PLAN.

Borough of Manhattan.

The entire borough has been fully mapped, with the exception of the Inwood Hill section, for which a tentative layout has been prepared, which will shortly come before the Board of Estimate for adoption. In connection with this layout a plan has been prepared providing for the extension of Riverside Drive to the Henry Hudson Memorial Bridge.

Final plans for the extension of Seventh Avenue from its present southerly end to Carmine Street, the widening of Varick Street from Carmine Street to Franklin Street, and the extension of Varick Street from Franklin Street to West Broadway near Leonard Street, have been completed, and are ready to be presented before the Board of Estimate for adoption.

Plans have been prepared for a change of grade on Park Avenue between Fortieth and Forty-second Streets, requiring a relocation of the street railway tunnel, so as to establish a grade crossing at Forty-first Street.

On West One Hundred and Thirty-fourth Street, between Broadway and Riverside Drive Viaduct, a unique plan of street building has been proposed. For a distance of 200 ft. west of Twelfth Avenue there will be a two-level street—a viaduct to connect with Riverside Drive and a low-level street directly underneath to connect with Twelfth Avenue. The purpose of this is to build a warehouse between the two street levels and an apartment house graded on the upper level.

A new tunnel street has been laid out from Bennett Avenue to Riverside Drive, and includes a shaft on Fort Washington Avenue, about 126 ft. deep. A direct connection will thus be made between the territory west of Broadway to the One Hundred and Ninety-first Street Subway station by way of this new tunnel, West One

Hundred and Ninetieth Street and Broadway surface, and a tunnel street previously laid out and now being constructed.

Borough of Brooklyn.

With the exception of the area adjoining Jamaica Bay, a street system has been provided for all of the territory within the limits of this borough.

During the year rule and damage maps have been prepared for 51 opening proceedings, comprising 92 streets, having a total length of 47.9 miles. 226 filing maps for change in street lines and grades have also been prepared.

Plans and profiles for grading contracts in this borough are prepared by the Topographical Bureau. The work of this character done during the year 1911 related to 297 improvements.

Borough of The Bronx.

The Borough of The Bronx has an area of 26 523 acres, of which 12 317.5 acres are located west of the Bronx River. The final maps for the latter area were completed in 1895 and included provision for about 375 miles of streets.

East of the Bronx River, the tentative plan of the street system is nearly completed, and 24 final sections, of which there are thirty-four in this district, have been filed, with dimensions and grades. There will be about 450 miles of streets in this district.

The monumenting of avenues and streets is progressing favorably, and 241 special orders were carried out for referencing and resetting monuments which were disturbed in connection with street improvements.

Rule maps and technical descriptions were prepared for 42 opening proceedings; draft damage maps in 61 proceedings and final damage and benefit maps in 24 proceedings.

Borough of Queens.

This borough comprises 75 111 acres, of which area 67 174 is land above water. With the exception of a few hundred acres, the topographical survey has been completed. An area of 63 364 acres has been mapped on a scale of 80 feet to the inch. Tentative maps of street plans and grades have been prepared for an area of 36 790 acres, and final maps, comprising an area of 22 982 acres, have been adopted.

During the year the maps relating to 49 proceedings for the acquisition of title to streets have been completed, as have also 17 maps required by reason of amendment to proceedings previously begun. At the close of the year the maps required for 90 additional proceedings were in various stages of completion.

Borough of Richmond.

Topographical Work.

Area of final maps completed* during 1911..........	546 acres
" " " under way December 31, 1911..........	185 "
" " " adopted during 1911..................	363 "
" " tentative maps completed* during 1911......	7 468 "
" " " " under way December 31, 1911.	8 739 "
" " " " approved during 1911........	1 550 "

PAVEMENTS.

During the past year new pavement has been laid in the boroughs as shown in the following table, the length in each case being indicated in miles:

Character.	Manhattan.	Brooklyn.	The Bronx.	Queens.	Richmond.	Total.
Sheet asphalt........	14.76	40.64	2.96	1.51	....	59.87
Asphalt block........	2.74	1.84	7.46	3.98	....	16.02
Wooden block........	4.63	1.13	0.17	....	1.57	7.50
Brick, slag and stone.	10.06	8.14	0.82	4.08	4.19	27.29
Macadam.............	......	0.03	....	4.14	0.17	4.34
Total...........	32.19	51.78	11.41	13.71	5.93	115.02

The total mileage of pavement in the boroughs as reported at the close of the year is as follows:

Character.	Manhattan.	Brooklyn.	The Bronx.	Queens.	Richmond.	Total.
Sheet asphalt........	254.16	438.07	41.70	21.86	0.46	756.25
Asphalt block........	55.10	29.16	56.45	14.24	9.53	164.48
Wooden block........	18.93	3.34	3.57	5.71	2.89	34.44
Brick, slag and stone.	108.48	216.16	41.72	48.70	19.24	434.30
Macadam.............	4.81	110.27	133.80	348.82	195.37	793.07
Total...........	441.48	797.00	277.24	439.33	227.49	2 182.54

*The maps designated as completed are those sent to the Board of Estimate and Apportionment for adoption and approval.

BOROUGH OF MANHATTAN.

During the year an appropriation of $400 000 was made for the widening of the roadways of some of the busiest thoroughfares in the City. This is a matter of great import, as the vehicular traffic on these streets became greatly congested, causing long delays on account of the narrowness of the roadways. Good progress has been made along these lines, and work has been completed or is now under way on the following streets:

5th Ave. (48th to 58th St.)	Roadway to be increased from 40 to 55 ft.
34th St. (Madison to 8th Ave.)	Roadway to be increased from 40 to 58 ft.
23rd St. (2nd to 8th Ave.)	Roadway to be increased from 40 to 58 ft.
42nd St. (Park to 8th Ave.)	Roadway to be increased from 40 to 55 ft.
14th St. (3rd to 6th Ave.	Roadway to be increased from 40 to 58 ft.
2nd Ave. (Houston to E. 23rd St.)	Roadway to be increased from 40 to 57 ft.
Lafayette St. (Gt. Jones St. to Astor Pl.)	Roadway to be increased from 40 to 55 ft.
Broadway (24th to 33rd St.)	Roadway to be increased from 39 to 48 ft.

In accomplishing this work, half of the increased width is taken from each sidewalk, and in order to increase the remaining sidewalk area, all encroachments along the line of work are ordered removed.

On Second Avenue it is planned to pave the widened street with a number of different pavements, the same class of pavement being laid in different blocks under different specifications. In this way the wearing qualities of the different pavements can be determined, and also how these may vary under different conditions.

On 4th Avenue, between 8th and 23rd Streets, an improved form of granite pavement has been tried. The stones are cut better than the ordinary granite block, with fair and true surfaces, so that a close joint can be obtained. This is considered by experts to be as fine a piece of pavement as there is in the City.

A novel piece of work has been placed under contract and a good start made in the construction of a tunnel street from a point near Broadway, to connect with One Hundred and Ninety-first Street Subway Station. The length of the tunnel will be about 900 ft., it will have a diameter of 12 ft., and is designed as an accommodation for pedestrians going to and from the Station.

BOROUGH OF THE BRONX.

Contracts were prepared and let for two transverse roads, in connection with the Grand Boulevard and Concourse, one at East

One Hundred and Seventieth Street, at an estimated cost of \$115 000, and one at East One Hundred and Seventy-fourth Street, at an estimated cost of \$103 000. The latter is a concrete arch, of approximately 100-ft. span, of very ornamental design and finish. Designs, plans, and specifications have been prepared for a third transverse road at the Bedford Park Boulevard and the Grand Boulevard and Concourse, the estimated cost of which is \$116 000. This improvement is now ready for letting. The reinforced concrete arch carrying Jerome Avenue over Mosholu Parkway, and the reinforced concrete retaining wall at Walker Avenue and the New York, New Haven and Hartford Railroad, have been completed. Both of these structures furnish good examples of reinforced concrete design and construction.

Considerable work has been done in the laying of small, well-dressed granite blocks with a cement grout filler, which has proven most satisfactory up to the present time. A considerable area has been repaved with redressed granite blocks with a grout cement filler, and has proven not only very economical, but most durable and satisfactory.

Beginning with the year 1911, the Water Sprinkling Division of the Bureau of Highways-Maintenance was abolished and a Division for Bituminous Applications for roadways was organized. Every macadam road and a number of earth roads in the borough received such treatment during the year. This method of treating macadam roads proved more efficacious and economical than water sprinkling, as will be seen from the following comparative costs:

Water sprinkling, including cost of water	5.2 cents per sq. yd. per year.
Bituminous application as dust layer	3 cents per sq. yd. per year.

Borough of Queens.

The United States Office of Public Roads and the Bureau of Highways, Borough of Queens, co-operated in laying eight adjoining sections of experimental pavements on Hillside Avenue, extending easterly two thousand feet from the crossing of the New York and Queens County Railroad near Flushing Avenue. Each section of pavement is laid in accordance with specifications, no patented

materials being used. Section one begins at the railroad crossing and runs eastwardly, the others follow in numerical order.

Section one has a length of 200 ft. and consists of oil-cement-concrete.

Section two has a length of 400 ft. and consists of cut-back oil asphalt mixed with cold stone.

Section three has a length of 400 ft. and consists of fluxed native asphalt mixed with cold stone.

Section four has a length of 400 ft. and consists of refined tar mixed with cold stone.

Section five has a length of 150 ft. and consists of oil asphalt. penetration method.

Section six has a length of 150 ft. and consists of refined tar, penetration method.

Section seven has a length of 150 ft. and consists of fluxed native asphalt, penetration method.

Section eight has a length of 150 ft. and consists of refined tar, penetration method.

The United States Office of Public Roads will publish in its "Progress Report" for 1911, a complete description of these experiments, and the conditions of the various experimental sections, as determined by inspections made by its representatives, will be published from time to time in later Progress Reports.

Borough of Richmond.

During 1911 an experimental pavement of clinker cement concrete was laid on Davis Avenue, West New Brighton. The concrete was composed of 1 part cement to 6 parts clinker, laid 6 in. deep, in squares of approximately 10 ft. on a side. The clinker was obtained at the Destructor Works, West New Brighton. The pavement has proven a failure.

The oil concrete pavement, laid on Innis Street during 1910, has not been successful.

The asphalt block pavement, laid on Fingerboard Road during 1910, has so far been very successful. This pavement was laid on the old macadam as a foundation, and is the only asphalt block on old macadam laid in the borough.

SEWERS.

During the past year sewers and receiving basins have been constructed in the boroughs as shown in the following table, the sewer length in each case being indicated in miles:

Character.	Manhattan.	Brooklyn.	The Bronx.	Queens.	Richmond.	Total.
Brick and concrete sewer.	0.34	*9.60	2.25	4.10	0.90	17.19
Pipe sewer..................	0.87	*30.40	10.56	5.24	3.37	50.44
Total.................	1.21	*40.00	12.81	9.34	4.27	67.63
Receiving basin......	21.	641	115.	134.	40.	951.

* Estimated.

The total number of receiving basins and mileage of sewers in the boroughs, as reported at the close of the year, is as follows:

Character.	Manhattan.	Brooklyn.	The Bronx.	Queens.	Richmond.	Total.
Brick and concrete sewer.	405.74	177.14	66.87	28.92	12.91	691.58
Pipe sewer...............	110.62	718.53	237.38	207.04	79.22	1 352.79
Total.................	516.36	895.67	304.25	235.96	92.13	2 044.37
Receiving basins.....	6 410.	11 255	3 467.	1 899.	871.	23 882.

Borough of Manhattan.

Most of the work of this borough relates to the maintenance of the sewerage system, which consists of basin cleaning, sewer cleaning and repairs to basins and appurtenances.

In the matter of basin cleaning the work has been carried on under a unit cost control system during the year, showing very satisfactory results. In the establishment of this system certain experimental and tentative method trials are necessary to arrive at a desirable permanent system, as the work is yet in a tentative stage. It is expected that the perfection of this system will very materially reduce the cost of removal per cubic yard of material from both basins and sewers.

Borough of The Bronx.

The important work in the borough is the trunk sewer in White Plains Road, Lacombe Avenue, Havemeyer Avenue and Lafayette Avenue, which was placed under contract in 1910, at an estimated cost of $621 000. At Zerega Avenue it receives the sewage from the large Lafayette Avenue sewer which was completed in 1909. The work is practically half completed. This trunk sewer drains an area of 7 500 acres.

STANDARD FORM OF SEWER CONTRACT AND SPECIFICATIONS.

The Board of Consulting Engineers arranged for the formation of a committee consisting of the Chief Engineers of Sewers of the several boroughs to prepare a standard form of sewer contract and specifications for use in all the boroughs. The committee was organized on December 4, 1911, and during the month held five meetings. Good progress has been made, the work of the committee will probably be completed by March, 1912.

RECORDS.

Borough of Brooklyn.

The Division of Substructures has completed plans showing in detail all of the subsurface structures in ninety miles of the streets in the most congested part of the borough; the work on many more miles is in progress.

The work of subsurface investigation commenced last year in co-operation with the Board of Water Supply, in order to determine an economical location for the large distribution mains to be installed as a part of the Catskill aqueduct system, was completed.

Borough of The Bronx.

Records have been compiled of all the public improvements in the borough as far back as 1902, and of financial matters as far back as 1906.

A complete record of street railway franchises has been compiled as far back as 1863, which includes all permits issued in that time by the Department of Public Parks, Commissioner of Street Improvements, the Borough Presidents, the Board of Electrical Control and other departments having jurisdiction.

The obligations of the City in regard to the construction and maintenance of railroad bridges have been tabulated.

A complete record of the paving of the streets on which railroad tracks are located is being prepared, in order that the City may compel the railway companies to meet their paving obligations.

An engineering and general library has been installed for the use of all employees.

BUREAU OF BUILDINGS.

The records of the Bureau of Buildings show that permits for new buildings and alterations of existing ones have been granted during the year as follows:

Boroughs.	New Buildings.		Alterations.	
	Number.	Estimated cost.	Number.	Estimated cost.
Manhattan	840	$98 587 275	3 686	$12 758 133
Brooklyn	5 288	32 596 240	7 178	5 112 827
The Bronx	1 357	22 887 060	618	1 576 247
Queens	5 374	22 204 255	1 277	801 283
Richmond	911	2 518 324	548	379 244
Total	13 770	$178 690 154	13 297	$20 622 684

A comparison of this record with that of 1910, shows that there has been an increase in the value of buildings erected in the Boroughs of Manhattan and Queens, and a decrease in the Boroughs of Brooklyn, The Bronx and Richmond and that the total volume of the year's work represents a value of 8% less than that for the preceding year. The detailed classification of buildings for which erection permits have been granted during the year in the Borough of Manhattan is as follows:

Classification.	No. of Buildings.	Estimated cost.
Dwelling houses, estimated cost over $50 000	12	$1 460 000
Dwelling houses, estimated cost between $20 000 and $50 000.	17	702 000
Dwelling houses, estimated cost under $20 000	10	101 500
Tenement houses	194	29 178 000
Hotels	10	5 900 000
Stores, lofts, etc., estimated cost over $20 000	116	19 961 000
Stores, lofts, etc., estimated cost between $15 000 and $20 000.	36	812 000
Stores, lofts, etc., estimated cost under $15 000	28	170 100
Office Buildings	51	19 591 800
Manufactories and workshops	36	4 829 450
Schoolhouses	10	1 380 000
Churches	19	1 304 000
Public buildings, municipal	17	1 298 300
Public buildings, places of amusement, etc	72	6 200 700
Stables and garages	65	1 443 180
Other structures	151	210 296
Railway stations	1	4 000 000
Total	840	$98 587 275

NEW YORK CENTRAL RAILROAD.

Grand Central Terminal Improvements.

The work which was begun in 1903 is now from 60 to 70 per cent. completed. The completed work extends from Lexington Avenue west about 700 ft. and from Forty-second Street to Fifty-seventh Street. The steel deck supporting the main level tracks has been erected over the Suburban Level for a considerable width. Some of the permanent tracks and platforms on both levels have been installed and others are under construction. The northerly half of the permanent Post-Office and Office Building is complete and the northerly half of the main station building is practically complete. The southerly half containing the waiting rooms, concourse, etc., is now under construction. The permanent sub-station, battery house and heating plant between Forty-ninth and Fiftieth Streets is practically complete and in this same block there is under construction a permanent building for the Adams Express Company. The first of the commercial buildings, the Merchants and Manufacturers Building, is now completed.

A considerable portion of the viaducts has been built along the northerly end of the work and on the easterly side of the work from Lexington Avenue to Park Avenue. Work on the remaining viaduct is proceeding.

There has been removed approximately 2 000 000 cu. yds. of excavation, about 150 000 cu. yds. of masonry have been placed, and 75 000 tons of steel erected.

NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.

Eight electrically operated apron transfer bridges, 130 ft. in length, replacing four transfer bridges of the pontoon type, 100 ft. long, were completed at Oak Point, Borough of The Bronx.

The six-tracked Harlem River Branch with all adjoining freight yards, is being electrified. The work is well advanced and it is expected to have it in operation the early part of the ensuing year. Freight as well as passenger trains will be propelled by electric power, it being the intention to do away with steam locomotives entirely, including switchers, on electrified divisions. The electrical equipment will take the power from an over-head catenary transmission line. The power will be single phase alternating current of 25 cycles at 11 000 volts.

HUDSON AND MANHATTAN RAILROAD.

No work of construction has been done during the past year, excepting the restoration of Sixth Avenue and the permanent replacement of the asphalt pavement, disturbed by the company in the conduct of its work, including the completion and restoration of the small City park known as Greeley Square.

NEW YORK, WESTCHESTER AND BOSTON RAILWAY.

The construction of the four track portion of the line between One Hundred and Seventy-fourth Street, Bronx, and Mount Vernon, and the two track portion from Mount Vernon to White Plains, has been rapidly advanced during the year in order to have the railroad ready for operation early in 1912. 97% of the grading and 91% of the masonry has been completed. Track is laid on 12 miles of the line, aggregating 35 miles of single track, which is 70% of the total trackage. The following steel work has been erected: one 4 000-ft. four-track subway; one four-track and one two-track viaduct, 35 railroad bridges; 21 highway bridges and one foot bridge. Four concrete arches of 20, 34, 50 and 70 ft. spans

have also been built. 68% of the steel catenary bridges are in place and 40% of the cables and wiring, have been strung. Two stations have been completed, while 18 others are under way. Work has also been commenced on the terminals at One Hundred and Eightieth Street, in The Bronx, and at White Plains. The buildings are steel, terra cotta and concrete, with stucco finish.

LONG ISLAND RAILROAD.

The new station at Forest Hills, mentioned in the report of last year, was completed. The work of rearranging the Jamaica facilities has progressed steadily, about 750 000 cu. yds. of fill having been brought in from Cold Spring and placed in embankment. A contract for the grade crossing elimination work throughout the Flushing territory was placed and the work started.

An agreement was executed with the City of New York, covering the elimination of grade crossings on the Woodside-Winfield Cut-off at Woodside Avenue, First Street, Fifth Street, Stryker Avenue, Woodside Avenue, Queens Boulevard, Laurel Hill Boulevard, Hyatt Avenue, Fisk Avenue and Ramsey Street, and the construction of bridges across several other streets, including Roosevelt Avenue, which is a new avenue.

Crossings are to be eliminated on the Montauk Division at St. Ann's Avenue, and Park Street, or Briggs Avenue, in Jamaica; Lefferts Avenue, in Richmond Hill; the crossings of the Main Line, Montauk and Atlantic Avenue Divisions at Van Wyck Avenue, in Dunton; Rockaway Road, in Jamaica; and on the Old Southern Road, at Beaver, Catherine and South Streets.

The agreement, also, provides for the construction of bridges or arches to carry the following new streets across the right of way, in connection with the Jamaica Improvement: Ashland Street, Ridgewood Avenue, Maure Avenue, Foley Avenue and Guilford Street; work was begun at a number of the streets.

Bay Ridge and Manhattan Beach Branches.

Under the direction of the Brooklyn Grade Crossing Commission about 3.5 miles of permanent main and yard track has been laid within the limits of the Borough of Brooklyn. A railroad

bridge at Sea Beach Crossing, foot-bridges at Livonia and Belmont Avenues, and highway bridges at Liberty and Glenmore Avenues, were constructed and put in service. A highway bridge at Second Avenue is partly completed.

CONCLUSION.

The compiler desires to express his appreciation of the services rendered by the officers of corporations, the heads of departments and the engineers in charge of work, who have willingly furnished the information on which this report is largely based.

ANNUAL DINNER.

The Ninth Annual Dinner of the Society was held at the Hotel Savoy, Fifty-ninth Street and Fifth Avenue, Saturday, January 6th, 1912, with a total attendance of 414 members and guests. President Henry W. Vogel, as toastmaster, introduced the three speakers: Mayor William J. Gaynor; President Lawson Purdy, of the Department of Taxes and Assessments; and President John H. Finley, of the College of the City of New York. Their subjects were respectively:

"His Excellency, Father Knickerbocker."
"Appreciation and Condemnation."
"The Future of Great Cities in the Light of History."

These addresses are printed on the following pages.

Music by H. Kühn's orchestra and entertainment by four vocalists from Wm. H. Tyer's bureau enlivened the time during which dinner was being served.

The sale of tickets netted a small cash balance which was applied to defraying the expense of a lecture by Frederick Monsen, on "My Friends, the Indians," for the annual meeting January 24th, which was made a ladies' night.

HENRY W. VOGEL, President and Toastmaster.—Gentlemen: I deem it a rare privilege to welcome the distinguished guests of the Municipal Engineers.

This gathering to-night is perhaps an indication of the growth of our Society. At our first dinner in 1904 there were 110 members and guests present. A better indication of our growth is the large attendance and the interest manifested at our monthly meetings, when papers on engineering works and problems are read and discussed.

The function of a presiding officer has been compared by some to the preface of a book, which is rarely read. A true preface does, however, give the key-note of the book.

A dinner, whether public or private, fails in its purpose if it does not leave a pleasant taste in the mouth and a useful or happy thought in the mind. It is very unusual nowadays, to find any one extolling the good things in municipal life; the good things are so

common-place they fail to arrest attention. We have been so continually engaged in the business of criticism that the faculty of admiring, of liking and of praising, seems to have become dormant. Wit and sarcasm frequently take the place of reason and argument. My thought to-night, briefly expressed, is this: While honest criticism is esential, civic pride is more important. This thought ends the preface.

It is eminently fitting that where so many members of an official body are assembled the head should be there also. Our Mayor, at a recent dinner of the Fifth Avenue Association, said that unjust criticism need not be feared if one has a contented mind and a little philosophy. Again, at a dinner given in honor of Lord Kitchener, about two years ago, our Mayor described a successful man as one who possesses two kinds of genius, the genius of detail and the genius of doing things on time. Our Mayor needs no other introduction.

HON. WILLIAM J. GAYNOR, Mayor.—Mr. Chairman and Gentlemen—(Applause): I suppose you all feel better after that—(Laughter). I would much prefer to say nothing. I feel that nothing that I may say to you in a desultory way will be adequate. I am among men who do things and who talk very little. Most of you that I know are as dumb as General Grant. You have nothing to say—(Laughter and applause). But all the same you know what to do and you do it. But I don't know where you all come from—that is what troubles me—(Laughter and applause). This program says, "Municipal Engineers of the City of New York." How many are there here? (A voice, five hundred.) There are nearly five hundred, and if Miller (turning to Borough President Miller) is any authority, he says that is not half of them—(Laughter). Waldo Smith just told me that he has a thousand—(Laughter). So there you are. The taxpayers now know where the money goes—(Laughter). I suppose a good many of you come from Cromwell's borough—(Laughter and applause). There is one Borough President of whom it is said that he pays more money to his engineers than to his laborers—(Laughter). I won't mention his name because it might hurt him at the next election—(Laughter), and yet may be it is justly so. We cannot do much without the engineers, if you will allow me to talk about engineers at all.

Some one put me down here with this toast, "His Excellency, Father Knickerbocker." Just think of that in a modern world. I have nothing to say about Father Knickerbocker. I never appeal to the wisdom of the ancients—(Laughter and applause). I happen to know what Sidney Smith had great trouble to convince the English people of—that we are the ancients. We are the oldest generation in all time up to the present and not the youngest. The world gets older as time goes along, not younger, and the human race gets older and not younger. So I appeal to the wisdom of the present time. And when I look over the world and see the engineering feats of the world and who did them, and come down to the modern world, I am more convinced than ever that I have no occasion to appeal to the wisdom of the ancients, especially in this presence—(Applause). The progress of the world is marked from the twilight of fable up to this hour by the work of the engineer. All that we have left of the ancient world, except what little literature of it is left to mark its greatness here and there, are the remains of engineering works. Anywhere that anything great was done the engineer was there. The pyramids still remain to attest the learning and ability of the engineers, even of that remote time. When Alexander went into Asia with his army, what would he have been about there except for his corps of engineers? I wonder how far he would have got. How far do you think? You know more about it than I do—(Laughter). I guess he would not have got across the borders of Greece, and all the marks that he left after him, all the great highways which he had to build for his armies as they penetrated into Asia, and the hills that he cut through, and the water that he had to supply to his army, all attest the importance of the engineer in those days.

We read of Cæsar in Gaul, and we put the history down as though Cæsar was up there only twenty-four hours or so, or twenty-four days, and fought a few splendid and brilliant battles and came back to Rome. But he was there ten long years. That is how long he was there. Get the sense of proportion in your minds. And without his engineers he could not have subsisted there for thirty days, and not ten years. He had to build his own roads, make his maps, and supply his army with water and food. He had to set up mills to manufacture his implements

of war even, and the clothing that his men wore, set up grist mills to grind corn to feed them, for you must remember that he had a hostile Rome back of him three-fourths of the time that he was in Gaul. And all this work depended on the intelligence and the fidelity of the engineer corps, did it not? It was not a mere stroke of genius that conquered Gaul. It was the patient work of ten years.

The genius of this world is the genius of getting ready. No genius can do much unless it gets ready, so that when the hour comes all things are gathered up in the hand and ready to be used in the most effective manner—(Applause). To state it otherwise, if I may do so without calculating words too finely, in order to get results you have to organize the conditions. In order to get a good breed of men, even, as well as a good breed of cattle, you have to organize the conditions, if I may say it—(Applause). But in your profession that sentence tells the whole truth. And you organize the conditions. Your prototypes were at the building of the walls of Babylon, were with Alexander in Asia, and were with Cæsar in Gaul. Without them Napoleon could not have won, I think he took a retinue of you with him into Egypt. I do not know what he did with them all when he got them there—(Laughter). But that is your office. I do not wish to extol it beyond what it actually is, and it is just as important to-day as it ever was.

In looking over the engineering things of the world, nothing has impressed me from the engineering point of view so greatly as the bridges. The great Tay bridge at Edinburgh almost appals a man to look at it, and yet for the big massiveness, for the strength, and for the lightness, and for the lines of beauty, these bridges over the East River surpass anything in the whole world in the way of engineering feats in my judgment. I always wonder what kind of a head or brain a man must have after building a great bridge, or getting through with some great engineering feat. I knew Charles C. Martin, the engineer with the two Roeblings, who built the Brooklyn Bridge. He was my intimate friend. Some people did not know why I appointed Martin Bridge Commissioner when I became Mayor. Well, I know. I knew his father, and I knew the breed and what they could do—(Laughter and applause),—

and I knew they didn't have much to say—(Applause). There is a passage in one of the apocryphal scriptures, "Blessed be the man who hath not slipped by a word out of his mouth." That would completely picture the elder Martin. What I was about to say is, what kind of a head had the man who designed one of those bridges, when he got through with it at all events. As I walk over the bridges and see the strands, the braces and the bolts and the million pieces, I wonder more and more every day—I would like to know what his brain looks like—(Laughter). I often thought I would like to get a peep into Martin's skull, inside of his skull, to see what was there, and I feel the same about Waldo Smith, to tell the truth—(Applause). When I went over his field in the Catskills and saw what he was doing, the same feeling came over me, and if it wouldn't kill him or hurt him, I would like to take a section out of his skull and peep inside—(Applause and laughter). There is no crow's nest in that man's head—(Laughter). It is wonderful. And yet it is no stroke or sleight of hand. It is not a thing done in a moment, as some of our young men now growing up think. They don't need to learn anything. Oh, they will do it by their genius and cleverness. Those are the fellows that never do anything—(Laughter). It has been said of my own profession, where we have to work, but in another way, that no great lawyer ever came to fame without a pale face or with a straight back. I think William M. Evarts said that. Some people think a lawyer with the big diamond in his bosom is the great lawyer—(Laughter). That is your calling, patience; infinite detail; hard work and getting ready, and accomplishing things. But I will not be so discursive as this. I can only say a few words to you. We are doing here in the Catskills one of the greatest engineering feats of modern times. I have here, I picked it up and brought over with me, Frontinus's history of the Roman water-works. I don't want you to make a run on the book stores Monday for a copy of it—(Laughter),—but Frontinus in a couple of chapters gives the history of the Roman water-works. He was the Water Commissioner of Rome, Mr. Thompson, (turning to Water Commissioner Thompson, who was present), under the Emperor Nerva —(Laughter),—and he calls himself Water Commissioner. In reading it all over, which I did some years ago, and taking it up

again this evening, I find the very same technical and scientific terms that you use to this day in your water-works. And when I went up to the Catskills and saw the work being done there, I saw that in some respects things were being done there that the Romans did, but they were being done far better than the Romans did them. Don't make any mistake about that—(Laughter). Let us not exalt what they did. It is true that they used concrete and used cement. It is true that they lined their aqueducts with concrete, as Mr. Waldo Smith is doing now. But they had no aqueduct with a bore or cross section of a diameter of fourteen feet, as we have in the aqueduct that comes under the Hudson River and down here from the Catskills. The largest, I think, that he mentions is 5 by 3½, or something like that. They did great things, but after all they were done in a rather clumsy way, and what we are doing will probably endure as long as what they did. They had their trouble too with contractors—(Laughter and applause). I cannot help referring to something—(Laughter). They had their water-works not only in Rome but in the cities throughout the provinces, and this was in a city by the name of Saldae—(Laughter and applause). I have a notion to spell it, S-a-l-d-a-e, and I have a notion to spell Frontinus. (A voice, spell it.) That is for the benefit of the newspaper men—(Laughter). Now they were bringing water into this city of Saldae, in the Province of Mauretania, and the engineers laid out a tunnel through the mountain, which was to be the aqueduct. They built tunnels in those days and they didn't cut them down from the top either, as some people want to convince you. They bored them right through. They had no blasting powder either. It is said you will find that the marks of the chisel with which they were hewed out are there. After laying it out, it was two miles long, I think, the engineer went off to another place, and here is a terse letter of the Governor of that Province to the Governor of Numidia to find the engineer and send him back as soon as possible, as he seemed to have neglected his work of building the aqueduct. So the engineer goes back and he makes a report. First he tells you (reading from Frontinus) he was waylaid by robbers on the way back, and nearly killed, and then he tells you when he got there he went to see the aqueduct and

everything had gone wrong—(Laughter),—and everybody was despondent. He said before he left he not only surveyed it and marked it out with great accuracy, but that he set them to work to see that they began right, and then he went away. Now whom do you think the engineer blamed? The contractors, he says—(Laughter). The contractors deviated from the line. The aqueduct was started on both ends and was to meet in the middle of the mountain, and he says that each contractor swerved to the right, and then he says, "Unless I had come back Saldae would really have had two aqueducts instead of one"—(Laughter and applause). He tells you he surveyed it all carefully, but he found they had deviated so far to the right that they never would meet in the middle of the mountain. They had already passed each other by a long distance—(Laughter), so the best that he could do was to put in a cross over from one to the other. Now, I only mention that to show you that they had the same old worry of those days that we have now—(Laughter). They had their troubles and they had contractors, and the engineers in those days, the same as now, threw the whole blame on the poor contractor—(Laughter). But enough of that. They had their day and we have ours. They did their work as well as they could. Their water-works, etc., they did well. The minuteness with which Frontinus tells it all is worth our emulation. His figures, however, are sometimes beyond my comprehension. He often apparently makes a mistake in his calculations but very likely it is the mistake of the monk who copied his manuscript, because it was kept and preserved in some monastery, where it was found, as is true of the Bible and most of the ancient books which we have which are worth talking about. However, some say that some of his calculations are wrong because of the difficulty in calculating in the Roman numerals. I am not so sure of that because Sir Isaac Newton invariably calculated and did his nicest calculations in the Roman numerals instead of the Arabic numerals. He said he could do it much more exactly and much more definitely. You know about that better than I do. You have your day and you are doing your work, and this great work up in the Catskills now drawing to a close is as great as any of them and much greater, because it is an improvement on all that has gone before,

and on the 30th of January, I think, Mr. Waldo Smith is going to take all of us,—maybe I have made a slip there, in all of us—(Laughter),—he is going to take up the Mayor and the Water Commissioner and the Water Board, at all events, and we are going through the tunnel under the Hudson, which will on that day connect or join, and we will be able to go from one end to the other. I have been there already. We came along and we were suddenly shot down about one-quarter of a mile into the bowels of the earth, and then we crawled in under as far as we could at that time. And now it is drawing to a completion. I don't mind, Waldo, if I do look down the neck of a bottle in there on the 30th of January—(Laughter and applause). I don't say I will drink, but I will do at least that much. I will look down the neck of a bottle—(Laughter),—because we will be celebrating one of the mightiest events that ever occurred in the world, and I hope that due notice will be taken of it—(Applause).

Now, gentlemen, I am glad to be here with you, and I am glad the City has so many good and intelligent and faithful engineers in its employ. I don't think any of you have a sinecure. If there be any such let them lift up their hands—(Laughter). I know it is no sinecure to be Mayor, and I dare say it is no sinecure to hold the positions which you hold, and you have nothing but my good-will in the work which you are doing for the community, whether the community appreciates it or not. (Applause.)

Henry W. Vogel, President and Toastmaster.—The problem of the most effectual, efficient and the fairest way of equalizing the burden of taxation is a problem that never has been and probably never will be satisfactorily solved. When you touch a man's pocket you touch a pretty sensitive spot.

President Purdy appreciates condemnation. Recently he advocated an amendment to the Constitution authorizing excess condemnation.

I take pleasure in introducing President Purdy.

Lawson Purdy.*—Mr. Chairman and Gentlemen: It is quite hopeless for any man to follow after the Mayor of New York and hope to be regarded as interesting. I can only serve as a foil for my successor, Dr. Finley, of New York City College.

* President, Department of Taxes and Assessments.

All these gentlemen here are only a fraction, Mr. Mayor, of the men who are eligible to join this Society. Your President tells me that there are some 2 200 and odd men in the City of New York eligible to join this Society and I have learned also the fraction of the City's Budget which is consumed by those eligible to belong to this Society. It may astonish even you when I say that there is only one city in the State of New York, outside of the City of New York, whose entire Budget equals the amount provided for the men eligible to join this Society.

The City of New York is said to be, and is, a very complicated piece of machinery. It is like one of those old-fashioned clocks that not only tells the time of day, but tells the day of the month and tells the year and exhibits the phases of the moon, for we are not only one simple machine doing one service, but a machine which includes within itself several different machines. There is the City Administration, and there are the Borough Administrations and there are the County Administrations and the State itself performs functions here for which the City of New York pays. That machine must be kept running, and, perhaps, the Department of Taxes and Assessments may be likened to the weights of that old clock—quite useless without the clock, but the clock would not run without the weights. The Tax Department is founded, and so the whole City Administration is founded, upon the engineer of the Tax Department who is the Surveyor of the Tax Department, and he is your President.

The men who make the assessments of property in the City of New York are called Deputy Tax Commissioners, and in our Department the bible of the Deputy Tax Commissioner is the field map that he carries with him; and so we get to think in terms of two dimensions. We live, it is true, in a three dimensional world, and you engineers that dig under the river and build bridges think in terms of three dimensions, but our tendency is to think of things with only length and breadth. We think in terms of city maps, and so in a way it is a particular pleasure to talk to you because you know what maps are, and when we talk about a map you make a mental picture of it. It is almost impossible to describe to the ordinary audience the problems that confront the Tax Department, which deals with maps, because the ordinary

man does not think in terms of maps; if you try to paint pictures for him that would be drafted by the draftsman, he finds difficulty in thinking of them.

To-night I shall talk to you on the subject dear to my heart, furthered by the Mayor, and one which I believe has much to do with the future development of the City. All of you are familiar with some street or other of the City that has been opened in recent years or widened, like Delancey Street, that forms the approach to the Williamsburgh Bridge, or like West Broadway that twenty years ago we widened, or like Elm Street, the north and south avenue that ten or twelve years ago we widened, and you know that those streets are not developed in accordance with the natural conditions that prevail upon them. If I describe to you what the map looks like, you will know why the streets look the way they do. As we go about our work in the Tax Department—and that work involves, often, as the President says, condemnation—we know why when we look on the map. The other day, in Brooklyn, we had complaints about assessments. The map was turned over and there was the reason for the complaint. It was a mass of criss-cross lines showing the old development, with streets running northeast and southwest, and superimposed upon them a new map of the City in an orderly way, with streets running north and south and east and west, and we had the triangles and the interior plots of land and the unusable piece of ground that led to the complaints of over-assessment, which were well founded. And so there on Delancey Street you have strips of land—one strip I remember only about 10 in. wide—running parallel and contiguous to the street and as effectually shutting off the land that lay to the south of it as though that strip had been 100 ft. instead of 10 in. You look at Elm Street to-day and you see along it a triangle with little shanties upon it. Right across the other side of Center Street towers eight-story modern loft buildings. Another place you see a vacant strip of land a few feet wide, and next to it the bare, blank, ugly wall of a modern building fronting on a street running east and west, whereas the building there should front on the thoroughfare running north and south. All those inharmonious, uneconomical conditions you are familiar with, and if you look on the map you see the cause why the parcels of land are of

shapes unusable and under conditions, oftentimes, of ownership which preclude for a generation their proper use. To prevent that condition in the future, there was recommended to the people of the State of New York, an amendment to the Constitution which would permit the City when it widens a street or opens a new street or opens a park, to take more land than that required for the widening of the street or the opening of the street, sufficient in size to leave suitable plots of land fronting on the new or widened street, so that the land may be appropriately developed as soon as the street is finished. After great labor and much explanation, that amendment was passed by two successive Legislatures and submitted to the people at the last election. The people of the City of New York appreciated its importance to the extent that they voted by some 50 000 or 60 000 majority for the amendment. It was lost, however, by the adverse vote of those who live north of the New York County line, and I fear because the first amendment suggested an increase of salary and the second amendment suggested another increase of salary, and by the time they got down to No. 4 they were discouraged and did not discriminate. We must, if we are to develop our City with economy and without undue burdens on large classes of the community, and with an eye to beauty, enlarge our powers along the lines of that amendment. Let me say a few words about those burdens that are imposed because we are obliged to do the work in the way it has been done.

During the last five years I have sat as a member of the Board of Revision of Assessors by virtue of my position in the Tax Department. That Board hears appeals from the work of the Board of Assessments who levy the assessments for local improvements. We heard the appeals of those who complained of assessments for the widening of Elm Street and for the widening of Delancey Street. They came to us and said, "Our assessments are grievous because we get no benefit from the widening of this street. Our lots lie parallel with the street, the widened street, and are shut off from it by a strip of land which we cannot cross. We have a building there suitable for its old location but which yields no greater return by reason of its being near to this widened street." A tenement-house, for example, which was within 10 ft. of Delancey Street before it was widened, produced certain revenue.

When it was a few feet nearer to the widened Delancey Street it produced no more revenue, and yet they were called upon to pay the large assessment upon land which ought to have been benefited by the widening of the street, which some day will have a greater value when it is connected with the other lots necessary to enable the owner to erect a suitable improvement, but which to-day produces no more revenue and has no greater advantage to the owner. We heard not one, but hundreds of such complaints, founded on fact, but impossible to relieve, and which cannot be relieved until the State permits the City to adopt those methods common in Europe which we here have not yet learned to imitate. Some of our neighboring States are imitating these European methods. You know how in London streets have been widened, and new streets opened, and the city has taken a strip of land on either side suitable for improvement, and has not only sold it or leased it at such a profit as materially to reduce the cost to the City of making the improvement, but has sold or leased, with proper restrictions, so that the new avenue shall be a thing of beauty, in its turn adding to its value, rather than a thing of such jagged sky-line.

There is no audience that I know which can so fully appreciate the condition that we now suffer under, and the possibilities which lie before us. Our City has grown to be four and one-half millions. What shall it be when it has doubled its present population? The new streets that must be cut through on this island of Manhattan and in the older parts of some of the other boroughs can hardly be imagined to-day. The requirements of travel are such that we can hardly think of them any more than the people forty years ago could dream of what we are to-day. Now is the time when we must prepare for that condition. I hope that you especially will do your part to bring about that change that we must have, that we may make the improvements of the future economical and beautiful and to the advantage of the generations that are to come.

HENRY W. VOGEL, President and Toastmaster.—A prophet is a man who sees a little more than his neighbor. He is one who foretells things not by reason of any occult power, but one who tells forth conclusions based on historical research, a knowledge of human nature and the tendencies of the time. Dr. Finley is actively

interested in social, intellectual and spiritual problems. He has traveled much and studied more. As President of the College of the City of New York, Dr. Finley daily watches the development of over 3 000 of our young men. "The youth of to-day is the ruler of to-morrow."

It gives me great pleasure to introduce Dr. Finley.

Dr. Finley responded to the introduction of the toastmaster, and entertained the Society with several amusing stories concerning the troubles often experienced by City officials in the discharge of their duties. He also called attention to the Prophet Jonah, who prophesied in regard to the ancient City of Nineveh, and who was afterwards much discredited because the Lord did not see fit to visit the punishment upon the City which Jonah had prophesied would occur.

Dr. Finley, therefore, declined to prophesy or to adhere strictly to the subject of his toast, "The Future of Great Cities in the Light of History." He told of the building of the first city by Cain; of the early vocationalizing of the descendants of Adam, and of the wonderful flight of civilization from city to city.

In closing, he spoke as follows:

"Cities have come and gone. The pre-Noachian cities were all swept away by flood. Sodom and Gomorra were burned with fire and brimstone. Jerusalem was destroyed, and her children wept beneath the willows of Babylon, who in turn saw her fate written in the handwriting on the wall. Rome herself became the tomb of her once proud spirit. Cities have sprung up by the shores, on the plains, by the rivers; have blossomed for a day and then have withered and died, but the city—the generic city—has risen from the ashes of the individual city, or it has climbed upon the broken walls. The specific city is mortal; *the* city, the generic city, is immortal."

"I have not looked over the results of the recent census, but it is not simply on this continent of ours that the cities are growing. Berlin in a decade ago grew as fast as Chicago, and Cologne as fast as Cleveland. Statistics of the growth of cities in this country are commonplace. I need not refer to them. It seems that everybody is moving into the urban environment; if he has not done so already, he expects to do so soon. This is a migration; it is not a growth. We are not indebted to our own fecundity for the growth of our city; it is to the people who come largely from the outside. * * *"

"The spirit of civilization has made the cities its stepping places. The old cities have passed away and the new have come. If there were time I might borrow some biological analogy to show how it is only through this great massing of people that certain achievements can be had." * * *

"I am not sure of this, but in reading the Revelation it has come to me that the place which has been pictured as the place of ultimate happiness is not the mountain side in the summer; it is not the orange grove in the winter; it is not a place by the sea; it is a city let down from the skies, a city that is not dependent upon the sun and moon for light; a city whose horseless streets are as smooth as glass; a city into which a stream of water is led clear as crystal, cold as snow, upon whose banks are trees planted for the healing of the air, and of the people who come into the city; a city whose gates are open in all directions and yet into which nothing is admitted which defileth; a city on whose assessment books are the names only of men possessed of character and of the right sort of personality. This is thought to be a city somewhere remote, but it is for you engineers, and for us who are working with you in a way, to make that city develop here in the latitude and longitude of the City of New York."

ASTORIA PLANT OF CONSOLIDATED GAS CO.

INSPECTED BY THE SOCIETY MARCH 25TH, 1911.

Through the courtesy of Mr. Colin C. Simpson, Superintendent of Mains, the new gas plant for the Consolidated Gas Company of New York at Astoria, L. I., was visited by 230 members of the Society on Saturday afternoon, March 25th.

The plant occupies a property of about 400 acres, located at Lawrence Point, at the extreme end of Long Island City, above Astoria. It is divided into six coal gas units of 20 million cu. ft. each, and three water gas units of 40 million cu. ft. each, making a total daily capacity of 240 million cu. ft. The property is of ample dimensions to permit three additional units of coal gas to be built without any disarrangement of the plant.

Every device known for the economical handling of the materials required for the manufacture of gas and the disposition of secondary products resulting from the operation of the plant, have been incorporated in the construction. The most modern appliances, many of them never before used in this country, for the purification and the elimination of objectionable and deleterious substances from the gas, have been adopted. As a result of this plant, in the near future Manhattan Island will possess the most perfect supply of manufactured gas that can be found in the world.

The coal storage capacity will provide for 90 days' supply. The location of the coal and coal handling docks and their mechanical equipments is a very important question. The plant when completed will daily carbonize 12 000 tons of coal, which will yield about 6 000 tons of coke. A large proportion of this material will have to be handled by water transportation. Work was begun on the plant in June, 1903. At the present time a portion of it is in operation.

The Company furnished transportation to and from the plant, and also provided a very excellent luncheon for the Society.

For the success of this inspection, the Society particularly owes its thanks to Mr. Colin C. Simpson and Mr. W. F. Lawrence.

THE NEW YORK PUBLIC LIBRARY BUILDING.

INSPECTED BY THE SOCIETY MAY 6TH, 1911.

Through the courtesy of the Hon. Chas. B. Stover, Commissioner of Parks, about 175 members of the Society and ladies enjoyed the privilege of inspecting the new Public Library Building on May 6, 1911.

From an architectural standpoint the New York Public Library probably is the most important building erected since the American architectural revival began. It may be said to embody most of what is good in contemporary American architecture.

The building has been planned to meet every reasonable practical requirement. Its arrangements for storing and handling the books are most satisfactory. The main reading-room is one of the most spacious rooms in the world. It is 395 ft. long, over 75 ft. wide and 50 ft. high. The stack room contains 412 000 lin. ft. of bookshelves, which will provide space for over three and a quarter million books.

The building, its equipment and the site, may be valued at between 16 and 17 million dollars.

THE NEW YORK BOTANICAL GARDEN.

INSPECTED BY THE SOCIETY JUNE 17TH, 1911.

Through the courtesy of Dr. W. A. Murrill, Assistant Director, a visit was made to the Botanical Garden on Saturday afternoon, June 17th. About 50 members of the Society attended.

The trip of inspection through the Garden was preceded by an illustrated lecture on "The Protection of Shade Trees," by Dr. Murrill.

The New York Botanical Garden contains about 250 acres of land situated in the northern end of Bronx Park. Its chief features are the Museum Building, the Public Conservatories, the collections of herbaceous plants and hardy trees and shrubs, the hemlock forest and the meadows along the Bronx River.

The inspection included the principal parts of the Garden, as follows:

Museum Building.—In addition to the botanical museum, the building contains the library, herbarium, laboratories, offices and public lecture hall. The main floor is devoted to the exhibition of numerous plant products.

Walk from Museum Building to Conservatory Range No. 2.—The route lies across Lake Bridge to the Fruticetum, thence across Long Bridge over the Bronx River and along the river to the Cherry Plantation, thence over the rocky ridge adjoining the conservatories.

Conservatory Range No. 2.—The plants of special interest here are the ferns and sago-palms, whose ancestors grew to immense size and produced the greater part of the world's coal supply.

Walk from Conservatory Range No. 2 to the Hemlock Forest.—The row of large tulip-trees on the left near the Boulder Bridge was observed, one of them badly attacked by a trunk-destroying fungus. On entering the forest, the stumps of chestnut trees killed by the canker were noticed.

Hemlock Forest.—This virgin forest, about forty acres in extent, is the most important natural hemlock plantation so far south on the Atlantic coast. It is preserved in its original form as far as possible. An effort is now being made to protect the roots from injury by trampling. During periods of drought, there is great danger from fire.

Herbaceous Valley.—This valley lies just west of the Hemlock Forest and is well adapted to the display of hardy herbaceous plants. Nearly 3 000 species are here arranged in their natural relationships.

Conservatory Range No. 1.—This range is 512 ft. long and 90 ft. high at the central dome, with fifteen inside compartments containing tropical plants, a large court on the south side with tanks for aquatic plants, and a flower-garden extending the entire length of the north side. Most of the cacti are planted in the outside court during the summer. Attention was called to the large collection of palms and orchids.

The Society is chiefly indebted to Dr. N. L. Britton, Secretary, New York Botanical Society, and to Dr. W. A. Murrill, Assistant Director, for the privileges it enjoyed on this inspection.

UNITED STATES NAVY YARD—DRY DOCK No. 4.

INSPECTED BY THE SOCIETY OCTOBER 7TH, 1911.

Through the courtesy of F. R. Harris, head of the Department of Public Improvements, about 75 members of the Society participated in a visit to the United States Navy Yard, in Brooklyn, on the afternoon of October 7th. The especial purpose of the trip was to afford the members an opportunity to examine the construction work, almost completed, of Dry Dock No. 4, but the following additional features of interest were shown.

The battleship *New York,* for which the keel members were erected on the ways and the plates forming the hull were in process of erection.

An exhibition of the "oxyacetylene gas torch."

A trip through the shops and the power plant, including the plate shop, blacksmith, machine and carpenter shops. In the plate shop the process of preparing the ships' plates was exhibited. In the blacksmith shop the operation of forging by heavy drop hammers was shown.

Next in order, the party was conducted over the work of Dry Dock No. 4; thence, dividing into two parties, one party was escorted on board the U. S. battleship *Utah* and the other party, on board the *North Dakota.*

Dry Dock No. 4 has been commonly known as the "hoodoo dock," because of the unsuccessful attempts to construct it. The work was authorized in 1900, but was not started until 1905, when George E. Spearin began the construction of a dock designed to be 542 ft. long by 130 ft. wide and 33 ft. deep, constructed of concrete on a pile foundation. The difficulties of carrying on the work under this design were increased by the quicksand which was encountered, and which partly wrecked the work itself and endangered the surrounding buildings. The contractor finally abandoned the work. Under this design the estimated cost of the work was $1 000 000.

After considerable delay, the work was again undertaken by the Williams Engineering Company, but they, also, were unsuccessful in its construction, on account of the difficulties met with in the shifting nature of the material, and the work was finally abandoned.

Subsequently, in 1909, the Holbrook, Cabot and Rollins Corporation were awarded a contract to complete the work. Up to this time various methods of holding the banks of soil in place by sheet-piling were tried without success.

In January, 1910, the entire design of the dry dock was revised, increasing the size of the dock to 700 ft. long by 110 ft. wide and 35 ft. deep over the sill. This design furnished a structure adequate for the reception of a vessel 685 ft. long and 108 ft. deep, or of about 50 000 tons displacement. These dimensions correspond to those of the widest ship that can pass through the Panama Canal locks, and allow for a considerable increase in the size of United States battleships.

On account of the failure of the sheet-piling methods pursued up to this time, the revised design provided for the construction of a continuous line of pneumatic caissons, bonded together, enclosing the entire site and forming a part of the permanent wall structure. The caissons were made to penetrate through the quicksand to stable material, and were sunk an average distance of 80 ft. below the original surface of the ground. The walls inside the caissons, forming the finished wall of the dock, are lined with vitrified paving brick keyed to the concrete backing.

In the original plan the concrete floor of the dock, 17 ft. in thickness, was designed to resist the theoretical upward hydrostatic pressure of the ground water. The reduction of the weight of the concrete floor made it necessary to provide reaction for the hydrostatic pressure by three longitudinal rows of concrete piers, 7 ft. square and 20 ft. apart longitudinally. These piers are carried to rock, or to good foundation, 35 ft. to 40 ft. below the dock floor, and have 11 by 11 ft. spread footings to increase the bearing surface, as well as to provide resistance to upward displacement. Vertical steel anchor rods are built into the concrete, which form a bond with the reinforcement bars in the dock floor.

The enormous horizontal thrust of the quicksand on the wall caissons is resisted by the arched arrangement of the latter at the head of the dock and by their strength as cantilevers, but when excavation was begun for the dock floor a system of framed transverse struts, reaching across the full width of the dry dock, from wall to wall, were put in place several tiers in height. The struts

were spaced 20 ft. apart horizontally and 9 ft. apart vertically, and are located on the center line between the interior floor piers.

Under the revised plan the work was carried to successful completion by Holbrook, Cabot and Rollins Corporation at a cost of approximately $2 750 000.

The Society is chiefly indebted to Civil Engineers Harris and Parsons and Naval Constructor Henry, representing the United States Government, and Engineer George Hallett Clark, representing the contractors for the dry dock, Holbrook, Cabot and Rollins Corporation, for the privileges enjoyed on this inspection.

BUSH TERMINAL.

INSPECTED BY THE SOCIETY NOVEMBER 18TH, 1911.

Through the courtesy of the Bush Terminal Company, 55 members of the Society visited its piers, warehouses and industrial properties on Saturday afternoon, November 18th.

The terminal is located in the Borough of Brooklyn. It extends from 28th Street to 53d Street, between Third and Second Avenues and the waterfront. The manufacturing, warehousing, railroad and steamship facilities, which the terminal affords, cover all together an area of 200 acres, and include the following:

Eight Model Lofts.—Buildings for manufacturing with room for 32 more. These are of reinforced concrete, 700 ft. long and 75 ft. wide, with sprinkler protection. Railroad tracks to each building.

Railroad Yard of 1 500 car capacity, with trackage for hundreds more.

Marine Equipment.—Twenty car floats, 30 lighters and covered barges and 10 tugs.

Auto Trucks and Horse Trucks for local deliveries.

One Hundred and Twenty-three Warehouses, for storage, containing 3 000 000 sq. ft. and having 26 000 000 cu. ft. of storage room. Railroad tracks to each warehouse.

Seven Steamship Piers.—Each 1 340 ft. long, 150 ft. wide and 270 ft. apart; railroad tracks the entire length of each pier, for transfer between car and vessel.

Twelve Locomotives.—Nine steam, 3 electric.

Hoisting Crane.—Ten tons capacity.

The Bush Terminal Company is an accredited terminal agent for all trunk line railroads. Rail shipments addressed to its tenants are delivered to the floor of the building occupied by the tenant, and called for there without extra charge. The dock facilities are most extensive and complete, and furnish cheap, convenient and expeditious water transportation.

The company offers a large storage capacity at low cost for space and insurance, excellent manufacturing facilities, a good labor market and unequaled transportation facilities.

The Society is particularly indebted to Mr. Simonds, Treasurer of the Company, for arranging the visit, and to Mr. Sturges for conducting the party over the properties and explaining their interesting features.

MEMOIRS OF DECEASED MEMBERS.

HORACE JOSEPH HOWE.*

Horace Joseph Howe was born at Lynn, Mass., on January 2d, 1860. He graduated from the Medford High School in 1875, after which he entered the Massachusetts Institute of Technology, graduating in 1879, with the degree of S. B. Immediately after his graduation he entered the service of the New York, Lake Erie, and Western Railroad, serving as Rodman, Inspector, and Draftsman. He remained with this company until July, 1881, when he went West and secured employment in the Construction Department of the Northern Pacific Railroad on the design of wooden bridges, shops, stations, etc., in Minnesota. In 1882, he was appointed Bridge Engineer on the Missoula Division, with headquarters at Missoula, Mont.

In July, 1885, when this work was completed, Mr. Howe came East and, until April, 1886, was employed as Inspector of Bridge Materials on the St. Louis and San Francisco Railway, under the late James Dun, Chief Engineer. He was also engaged on bridge work under the late George S. Morison.

In April, 1886, Mr. Howe re-entered the service of the New York, Lake Erie and Western Railroad, and was employed until April, 1894, in the Maintenance of Way Department, mostly on the Delaware and Susquehanna Divisions, and also as Roadmaster on about 200 miles of the New York, Pennsylvania and Ohio Railroad, a leased line.

In September, 1894, he was appointed Assistant Engineer with the Boston Transit Commission, on preliminary surveys, testing, estimating, designing, etc. He remained with the Commission until 1897, when the work on the Subway was completed. He was then appointed Assistant Engineer on construction work at Forest Hills, for the New York, New Haven, and Hartford Railroad. He was also engaged for a time as Assistant Engineer on the New York Central and Hudson River Railroad.

*Memoir prepared by Theodore Belzner.

In 1900 Mr. Howe became an Assistant Engineer for the Rapid Transit Railroad Commission, and, later, for the Public Service Commission, of New York City, which position he held at the time of his death, his work in connection with the construction of the New York Subway, namely, the Manhattan Valley Viaduct, the West Side Viaduct and Extension, the Van Cortlandt Park Extension, and in the moving of the old and the replacing of the New Harlem Ship Canal Bridge, showing his ability in his profession. He presented a paper on the latter subject entitled "Notes on the Replacing of the Superstructure of the Harlem Ship Canal Bridge,"* before the American Society of Civil Engineers on January 5th, 1910. Another valuable paper, entitled "Some Instances of Piles and Pile-Driving, New and Old,"† by Mr. Howe, was presented before the Boston Society of Civil Engineers on March 30th, 1898. He was also an occasional contributor to professional discussions of this Society, as well as to those of other engineering societies.

Mr. Howe was a gentleman of kindly disposition and remarkably even temperament. He was loyal to his friends and kind and considerate to his subordinates. His ability as an engineer and his value as a citizen was recognized by all his associates.

He was a Member of the American Society of Civil Engineers, the Boston Society of Civil Engineers, the National Civil Service Reform Association, the Technology Club of New York, and a Charter Member of the Municipal Engineers of the City of New York. He was actively interested in church work, and was Treasurer of the Unitarian Club of Yonkers. He was also a Member of the Yonkers Choral Society, having served as an officer for many years.

In 1899 Mr. Howe was married to Miss Stella S. Weston, of Medford, Mass., who, with three sons and a daughter, survives him.

At the time of Mr. Howe's death he was Assistant Division Engineer of the Fourth Division, First District, Public Service Commission; his work in connection with the construction of the Manhattan Valley Viaduct, etc., was that of Resident Engineer.

---

* *Transactions*, Am. Soc. C. E., Vol. LXVII, p. 1.

† *Journal*, Association of Engineering Societies, Vol. XX, p. 257.

Mr. Howe had attended the Annual Reception of the American Society of Civil Engineers on January 18th, 1911, this being the last social evening that he and Mrs. Howe enjoyed together outside of their home, and on January 21st he died suddenly at his home in Yonkers, N. Y., of paralysis of the heart.

JOHN JOSEPH McLAUGHLIN.*

John Joseph McLaughlin was born on September 16th, 1860, in the village of Jamaica, Long Island. He was educated in the public schools in Jamaica, and in 1879 graduated from the New York University with the degrees of B. S. and C. E.

From the time of his graduation to 1887 he was in charge of the work of R. L. Waters, a City Surveyor of Manhattan, who, at that time, was making the surveys for all the large parks in the Borough of the Bronx. In 1887 he opened an engineering office in the 26th Ward (New Lots), Brooklyn, where he did considerable municipal, as well as private work. In the year 1891 he removed his office to Jamaica, where he, with several other influential men, organized the publication of "The Benefits of Good Roads," which has since become world-wide.

During the years 1892 and 1893, the Town of Jamaica, under his supervision, built about 40 miles of Macadam roads, and in October, 1893, he was appointed County Engineer of Queens County, which position he held until December 31, 1898, the date of the County and City Consolidation. During this time the County and Town Municipalities built, under his supervision, nearly four-hundred miles of Macadam roads in the County, and at the time of Consolidation, the Queens County system of roads was the finest in this country.

Mr. McLaughlin was the engineer for the construction of the Grand Street and Meeker Avenue Bridges over Newtown Creek, between Kings and Queens Counties. He also was the engineer for the Jamaica Sewer Commission, under whose jurisdiction the sewers were constructed in the village of Jamaica.

---

* Memoir prepared by Robert R. Crowell, M. M. E. N. Y.

In 1902 the President of the Borough of Queens appointed him Consulting Engineer of the borough, which position he held until June 30th, 1910, at which time he resigned.

For thirty years he had been a tireless worker at his profession, and although a very busy man he always had time to listen and advise the younger members of his profession, upon intricate problems which confronted them.

The engineering profession has lost a prominent member and a loyal supporter, and his acquaintances, a warm friend.

He was a member of the American Society of Civil Engineers, the Brooklyn Engineers Club, the Municipal Engineers of the City of New York, and a large number of fraternal, social and political organizations.

He died on January 19, 1911. A widow, Adelaide M. McLaughlin, and eight children survive him.

GEORGE HOFFMAN.*

George Hoffman was born in the City of New York on the 24th of January, 1859. After graduating from the New York Public Schools and from the College of the City of New York, he took a course in Engineering from the Scranton Correspondence School, from which he graduated with a degree of Civil Engineer.

In 1888 he opened an office as an architect at No. 520 Broadway, New York City. In September, 1898, he was appointed to a position in the Building Bureau of the Department of Education, and during his connection with this Bureau, he was employed as special draftsman on structural steel work.

Mr. Hoffman also served as consulting architect for the construction and building of the Bronx Consumer's Ice Plant, the St. John's College, Fordham, and Manhattan College, Pocantico Hills. He was also associated with Major John E. Kirby in the designing and building of several churches in Brooklyn, Peekskill, and the Borough of Bronx.

Mr. Hoffman died on September 14th, 1911. A wife and a son survive him.

---

* Memoir prepared by George Krug, Sr., M. M. E. N. Y.

INFORMATION.

MEETINGS.—Regular meetings are held in the Engineering Societies Building, No. 29 West 39th Street, Manhattan, on the fourth Wednesday of each month at 8:30 P. M., except in June, July and August. The Annual Meeting is held on the fourth Wednesday in January.

LIBRARY.—The Society rooms and library are open every day and evening, including Sundays and holidays. Keys may be obtained from the Secretary on the deposit of 25 cents each.

Members of the Society and all who feel an interest in the maintenance of a technical reference library, devoted more especially to the subject of municipal engineering, are asked to donate engineering books, reports, specifications, maps, plans and photographs.

PROCEEDINGS.—The Society issues one volume of PROCEEDINGS each year, usually in May. It contains all of the papers presented during the preceding year, the annual address of the President, the final reports of special committees on professional subjects, descriptions of the works visited by the Society, and the speeches delivered at the annual banquet, which are of permanent value.

Proceedings are furnished without extra charge to members, and are sold for $2.00 in cloth and $1.50 in paper. Exchanges are desired with other societies, libraries, colleges, etc.

PAPERS.—Papers and discussions on subjects of engineering interest are invited from all persons, whether members of the Society or not. They are, of course, subject to proper editorial supervision. All papers on their acceptance become the property of the Society.

BADGES.—The badge of the Society is of gold with blue enamel in the design shown on the title page of this book. It has a number engraved upon the back, and may be obtained as a pin, a watch charm, or a button. The price is $4.00. Application for it should be made to the Secretary.

CERTIFICATES OF MEMBERSHIP.—The certificate of membership is steel-engraved on parchment paper, engrossed with the name of the member and the date of his election; the seal of the Society is impressed, and it is signed by the President and the Secretary. The size is 14 by 18 inches, and the price is $2.00. Application for it should be made to the Secretary.

DUES.—The dues for Resident Membership are $10.00 a year, for Non-resident Membership, $5.00 a year.

REMITTANCES.—All remittances should be made payable to the order of Municipal Engineers. They should be made by check on New York or by post-office or express money order payable at New York.

ABBREVIATION FOR MEMBER.—The Board of Directors has authorized the use of the abbreviation "M. M. E. N. Y.," to signify "Member of the Municipal Engineers of the City of New York."

OFFICERS FOR 1911.

PRESIDENT

HENRY W. VOGEL.

FIRST VICE-PRESIDENT

SIDNEY W. HOAG, Jr.

SECOND VICE-PRESIDENT

FREDERICK C. NOBLE.

SECRETARY

CLARENCE D. POLLOCK.

TREASURER

HERMAN K. ENDEMANN.

DIRECTORS

Term expires January, 1912.

GEORGE L. CHRISTIAN, JOHN T. FETHERSTON,
GEORGE R. FERGUSON, ALFRED D. FLINN,
JOHN H. WEINBERGER.

Term expires January, 1913.

EDWARD P. HERRMANN, F. X. A. PURCELL,
WILLIAM F. LAASE, WINFRED H. ROBERTS,
GARDNER L. VAN DUSEN.

Term expires January, 1914.

AMOS L. SCHAEFFER, EDWARD M. LAW, Jr.
DANIEL L. TURNER, EDWARD A. MILLER,
EDWIN J. FORT.

PAST-PRESIDENTS

GEORGE W. TILLSON, GEORGE S. RICE,
ROBERT RIDGWAY, ROBERT R. CROWELL,
ARTHUR S. TUTTLE.

COMMITTEES FOR 1911.

The President is *ex officio* a member of all committees.

STANDING COMMITTEES.

FINANCE

SIDNEY W. HOAG, Jr., Chairman; JOHN T. FETHERSTON, EDWARD A. MILLER, C. V. V. POWERS, WINFRED H. ROBERTS.

MEMBERSHIP

FREDERICK C. NOBLE, Chairman; GEORGE R. FERGUSON, WM. F. LAASE, F. X. A. PURCELL, JOHN H. WEINBERGER.

PUBLICATION AND LIBRARY

GEORGE A. TABER, Chairman; KENNETH B. EMERSON, LEON G. GHETTI, EDWARD P. HERRMANN, JOHN J. KLETCHKA, VERNON S. MOON.

HOUSE

ALFRED D. FLINN, Chairman; JOHN R. HEALY, DANIEL D. JACKSON, FREDERICK W. RUBIEN, ROBERT A. WIMMER.

INSPECTIONS COMMITTEE

DANIEL L. TURNER, Chairman; EDWARD A. BYRNE, LLEWELLYN W. FREEMAN, AMOS L. SCHAEFFER, JESSE O. SHIPMAN.

PRIZES

GEORGE W. TILLSON, Chairman; SAMUEL C. THOMPSON, ARTHUR S. TUTTLE.

SPECIAL COMMITTEES.

RAINFALL AND RUN-OFF

EDWIN J. FORT, Chairman; HORACE LOOMIS, EDWARD W. WOOD, ALBERTO SCHREINER, VICTOR H. REICHELT.

LICENSING ENGINEERS

GEORGE W. TILLSON, Chairman; SAMUEL C. THOMPSON, GEORGE S. RICE, ROBERT RIDGWAY, ROBERT R. CROWELL, ARTHUR S. TUTTLE.

PRESERVATION OF CORE BORINGS

GEORGE S. RICE, Chairman; ALFRED D. FLINN, JAMES F. SANBORN, JOHN A. KNIGHTON.

AUXILIARY MEMBERSHIP

GEORGE L. CHRISTIAN, Chairman; A. G. BOUTON, W. C. BUNTING, G. J. F. CAREY, W. H. CHERRY, F. A. DRAKE, J. R. FERRIS, M. L. FOUQUET, W. B. GRUBBE, E. P. HERRMANN, J. L. HOGAN, J. P. HOGAN, E. B. JOHNSON, H. S. R. McCURDY, W. W. PEABODY, F. X. A. PURCELL, E. P. RAMSEY, B. W. RONZONE, J. F. SANBORN, J. B. STEIN, W. F. STEINMETZ, A. THOMSON, Jr., L. WHITE.

OFFICERS FOR 1912.

PRESIDENT.

SIDNEY W. HOAG, Jr.

FIRST VICE-PRESIDENT

ALFRED D. FLINN,

SECOND VICE-PRESIDENT

THEODOR S. OXHOLM.

SECRETARY

CLARENCE D. POLLOCK.

TREASURER

HERMAN K. ENDEMANN.

DIRECTORS

Term Expires January, 1913.

EDWARD P. HERRMANN,
FREDERICK C. NOBLE,
WILLIAM F. LAASE,
WINFRED H. ROBERTS.
GARDNER L. VAN DUSEN.

Term Expires January, 1914.

AMOS L. SCHAEFFER,
EDWARD M. LAW, Jr.
DANIEL L. TURNER,
EDWARD A. MILLER.
EDWIN J. FORT.

Term Expires January, 1915.

NOAH CUMMINGS,
FRANK E. WINSOR.
WILLIAM W. BRUSH,
JOHN P. BINZEN, Jr.
J. WALDO SMITH.

PAST-PRESIDENTS

GEORGE S. RICE,
ROBERT RIDGWAY.
ROBERT R. CROWELL.
ARTHUR S. TUTTLE
HENRY W. VOGEL.

COMMITTEES FOR 1912.

The President is *ex officio* a member of all committees.

STANDING COMMITTEES.

FINANCE.

ALFRED D. FLINN, Chairman; NOAH CUMMINGS, WILLIAM F. LAASE, C. V. V. POWERS, CHARLES E. GREGORY.

MEMBERSHIP.

THEODOR S. OXHOLM, Chairman; EDWARD A. MILLER, DANIEL L. TURNER, WILLIAM W. BRUSH, JOHN P. BINZEN, Jr.

PUBLICATION AND LIBRARY.

GEORGE A. TABER, Chairman; EDWARD M. LAW, Jr., JOHN J. KLETCHKA, KENNETH B. EMERSON, VERNON S. MOON, ASHER LIPMAN.

HOUSE.

EDWARD P. HERRMANN, Chairman; MORTON L. FOUQUET, WILLIAM G. FORD, ROBERT A. WIMMER, CHARLES GARTENSTEIG.

INSPECTIONS.

WINFRED H. ROBERTS, Chairman; AMOS L. SCHAEFFER, CHARLES R. WARD, ALBERT H. CHANDLER, EDWARD B. JOHNSON.

PRIZES.

GEORGE S. RICE, Chairman; HORACE LOOMIS, FREDERICK C. NOBLE.

SPECIAL COMMITTEES.

RAINFALL AND RUN-OFF.

EDWIN J. FORT, Chairman; HORACE LOOMIS, EDWARD W. WOOD, ALBERTO SCHREINER, VICTOR H. REICHELT.

PRESERVATION OF CORE BORINGS.

GEORGE S. RICE, Chairman; ALFRED D. FLINN, JAMES F. SANBORN, JOHN A. KNIGHTON.

PAST AND PRESENT OFFICERS.

Officers of the Society since its organization.

PRESIDENTS

NELSON P. LEWIS	1903-4
SAMUEL C. THOMPSON	1905
GEORGE W. TILLSON	1906
GEORGE S. RICE	1907
ROBERT RIDGWAY	1908
ROBERT R. CROWELL	1909
ARTHUR S. TUTTLE	1910
HENRY W. VOGEL	1911
SIDNEY W. HOAG, Jr.	1912

FIRST VICE-PRESIDENTS

**OTHNIEL F. NICHOLS*	1903
SAMUEL C. THOMPSON	1904
HENRY A. LA CHICOTTE	1905
GEORGE S. RICE	1906
ROBERT RIDGWAY	1907
ROBERT R. CROWELL	1908
ARTHUR S. TUTTLE	1909
HENRY W. VOGEL	1910
SIDNEY W. HOAG, Jr.	1911
ALFRED D. FLINN	1912

SECOND VICE-PRESIDENTS

SAMUEL C. THOMPSON	1903
HENRY A. LA CHICOTTE	1904
GEORGE W. TILLSON	1905
ROBERT RIDGWAY	1906
ROBERT R. CROWELL	1907
ARTHUR S. TUTTLE	1908
CHANDLER WITHINGTON	1909
SIDNEY W. HOAG, Jr.	1910
FREDERICK C. NOBLE	1911
THEODOR S. OXHOLM	1912

SECRETARIES

WISNER MARTIN	1903-4-5-6
CLARENCE D. POLLOCK	1907-8-9-10-11-12

TREASURERS

ARTHUR S. TUTTLE	1903-4-5-6-7
HENRY W. VOGEL	1908-9
HERMAN K. ENDEMANN	1910-11-12

DIRECTORS

RUDOLPH HERING	1903
ROBERT RIDGWAY	1903-4-5
**WILLIAM S. DALRYMPLE*	1903-4
ROBERT R. CROWELL	1903-4-5-6
FREDERICK SKENE	1903
GEORGE S. RICE	1903-4-5

** Deceased.*

MAX RAYMOND	1903-4
HENRY R. ASSERSON	1903-4-5-6-7
BERNARD M. WAGNER	1903-4
THEODOR S. OXHOLM	1903-4
C. B. J. SNYDER	1903-4-5
JOHN C. WAIT	1903-4-5
EDWARD A. MILLER	1903-4-5-11-12-13
GEORGE W. TILLSON	1903-4
FREDERICK GREIFFENBERG	1903-4-5
CHANDLER WITHINGTON	1904-5-6
HAROLD TAIT	1904-5-6
BENJAMIN S. WEVER	1905-6-7
EDWARD A. BYRNE	1905-6-7
LLEWELLYN W. FREEMAN	1905-6-7
ANDREW J. PROVOST, Jr	1905-6
ELMORE F. AUSTEN	1905-6
MARTIN GAY	1906-7-8
HERMAN K. ENDEMANN	1906-7-8-9
WILLIAM R. HILLYER	1906-7-8
EDWARD L. HARTMANN	1906-7-8
GEORGE R. OLNEY	1906-7-8
CLARENCE D. POLLOCK	1906
WILLIAM D. LINTZ	1907-8
ALBERTO SCHREINER	1907-8-9
FREDERICK C. NOBLE	1907-8-9-12
CORNELIUS V. V. POWERS	1907-8-9
DANIEL D. JACKSON	1907-8-9
EDWARD H. HOLDEN	1907-8-9-10
GEORGE W. TUTTLE	1908-9-10
GEORGE A. TABER	1908-9-10
EDMUND J. MAURER	1908-9-10
EDWIN J. FORT	1908-9-10-11-12-13
GEORGE L. CHRISTIAN	1909-10-11
JOHN T. FETHERSTON	1909-10-11
GEORGE R. FERGUSON	1909-10-11
ALFRED D. FLINN	1909-10-11
JOHN H. WEINBERGER	1909-10-11
EDWARD P. HERRMANN	1910-11-12
WILLIAM F. LAASE	1910-11-12
F. X. A. PURCELL	1910-11
WINFRED H. ROBERTS	1910-11-12
GARDNER L. VAN DUSEN	1910-11-12
DANIEL L. TURNER	1911-12-13
EDWARD M. LAW, Jr.	1911-12-13
AMOS L. SCHAEFFER	1911-12-13
NOAH CUMMINGS	1912-13-14
FRANK E. WINSOR	1912-13-14
WILLIAM W. BRUSH	1912-13-14
JOHN P. BINZEN, Jr	1912-13-14
J. WALDO SMITH	1912-13-14

AWARD OF PRIZES.

These papers will be found in the Proceedings for the years indicated

1903.

JAMES COPPER BAYLES, M. M. E. N. Y., for paper entitled : The Problem of t[illegible] Maintenance of Asphalt Pavements in Manhattan.

1904.

GEORGE WILLIAM TILLSON, M. M. E. N. Y., for paper entitled: The Mainte[illegible] and Repairs of Asphalt Pavements.

1905.

SIDNEY WILLETT HOAG, Jr., M. M. E. N. Y., for paper entitled : The D[illegible] Department and the New York Docks.

1906.

ALFRED DOUGLAS FLINN, M. M. E. N. Y., for paper entitled : The Organiza[illegible] of an Engineering Force in New York City.

1907.

EDWARD HENRY HOLDEN, M. M. E. N. Y., for paper entitled : Traverse W[illegible] in Connection with the Triangulation of Bronx Borough.

1908.

ROBERT RIDGWAY, M. M. E. N. Y., for paper (Northern Aqueduct Departme[illegible] entitled: Subsurface Investigations of the Board of Water Supply for t[illegible] Proposed Catskill and Long Island Aqueducts and Reservoirs.

1909.

THOMAS HOLLIS WIGGIN, M. M. E. N. Y., for paper entitled: The Design o[illegible] Pressure Tunnels of the Catskill Aqueduct.

1910.

FREDERICK S. COOK, M. M. E. N. Y., for paper entitled: Construction of th[illegible] Croton Falls Reservoir, New York City Water Supply.

PAST PRESIDENTS' MEDALS.

NELSON PETER LEWIS 1903-4
SAMUEL CLARENCE THOMPSON 1905
GEORGE WILLIAM TILLSON 1906
GEORGE STAPLES RICE 1907
ROBERT RIDGWAY 1908
ROBERT REYNOLDS CROWELL 1909
ARTHUR SMITH TUTTLE 1910
HENRY WILLIAM VOGEL 1911

INDEX TO PREVIOUS VOLUMES.

PROCEEDINGS FOR 1903.

PROCEEDINGS FOR 1904.

* Prize paper.

PROCEEDINGS FOR 1905.

PROCEEDINGS FOR 1906.

* Prize paper.

* Prize paper.

PROCEEDINGS FOR 1908.

PROCEEDINGS FOR 1909.

* Prize paper, portion by Mr. Robert Ridgway.

PROCEEDINGS FOR 1910.

* Prize paper.

*Prize paper.

INDEX TO ADVERTISEMENTS.

The advertisements appearing herein have been reprinted on cards 5 ½ by 6 inches in size, each card bearing the official seal of the Society. They form a collection of data cards descriptive of

ENGINEERING AND CONTRACTING EQUIPMENT AND SUPPLIES

and have been distributed to each member of the Society, and to numerous engineering societies and libraries. It is proposed to make this list more complete with each issue of this volume.

THE MUNICIPAL ENGINEERS
OF THE CITY OF NEW YORK

W. J. FITZGERALD

CONTRACTOR

547 WEST 45TH STREET

NEW YORK

TELEPHONE 19 BRYANT

Dealer in

New and Second-Hand
Paving Blocks

of every description

Joseph Johnson's Sons

GENERAL CONTRACTORS

Estimates Given for the Construction of Macadam Roads,
Boulevards, Sewers, Grading, Excavating,
Flagging, Curbing.

Laying Out Lawns. All Kinds of Trucking Attended to.

455 BROADWAY

Telephone 377, W. B. **West New Brighton, N. Y.**

T. FREDERICK JACKSON, Pres. and Treas. A. AROWITZ, Sec'y.

T. FREDERICK JACKSON, Inc.

ELECTRICAL CONTRACTORS

94 JOHN STREET

PHONE JOHN 764 NEW YORK

TELEPHONE 3550 CHELSEA

CHARLES H. PECKWORTH

Building Contractor

631 Hudson Street NEW YORK

SEA VIEW HOSPITAL STATEN ISLAND RAYMOND F. ALMIRAL, ARCHITECT

LUKE A. BURKE & SONS CO., Inc.

BUILDERS, ENGINEERS AND CONTRACTORS

25-27 West 42d Street Telephones: 2334-2335-2336 Bryant **New York City**

FOUNDATION WORK A SPECIALTY

MURPHY BROTHERS

Contractors

Corner 25th and Cropsey Avenues

BROOKLYN, N. Y.

TELEPHONE, 71 BATH BEACH

ANDREW R. BAIRD, V.-Pres. ANDREW D. BAIRD, Pres. WILLIAM W. BAIRD Sec'y & Treas.

Andrew D. Baird & Sons

INCORPORATED

Cut Stone Contractors

COR. WYTHE AVENUE AND KEAP STREET

BOROUGH OF BROOKLYN, N. Y.

Telephone: 455 Williamsburgh

HOWARD CARROLL, President | GEORGE C. CLAUSEN, Vice-Pres. and Treas. | H. HAGGERTY Secretary

The
SICILIAN ASPHALT PAVING COMPANY
41 PARK ROW, NEW YORK

ARCHITECTS AND ENGINEERS SHOULD SPECIFY

Sicilian Rock Asphalt Mastic

Brand of "The United Limmer & Vorwohle Rock Asphalte Company" for Floors and Pavements of Hospitals, Cellars, Kitchens, Breweries, Warehouses, Manufactories, Railroad Platforms, Sidewalks, Slaughter Houses, Stables, etc.

FIREPROOF AND DURABLE

Estimates for the work complete furnished to Builders, or Asphalt Mastic, etc., sold to Asphalt Paving Contractors.

SOLE MANUFACTURERS OF

SIASTEX Waterproofing Fabric

An asphalted textile unequaled in strength, toughness and elasticity.

CONTRACTORS FOR AND DEALERS IN

ASFALTO, the Ideal Dustless Macadam Roadway

U S

Wood Block Pavement

MARKET STREET, PHILADELPHIA, PA., PAVED WITH U. S. WOOD BLOCK PAVEMENT

AN EXPERT'S OPINION

THE City Council of Pottsville, Pa., asked Mr. Wm. S. Pugh, the City Engineer, for an opinion as to the respective merits of creosoted wood block and vitrified brick. The City Engineer, after travelling extensively in cities where both pavements were used, reported strongly in favor of wood block, and the same was subsequently adopted by the Council as a paving for certain streets in Pottsville.

The following is a typical excerpt from the report:

"In Philadelphia I carefully examined the conditions of Market Street, paved during the fall of 1909, and with which so many members of Council are familiar. I found it, as I think all who have seen it will agree, a beautifully paved street teeming with traffic, which included hundreds of pleasure loving automobiles and light carriages, as well as an almost countless number of the heaviest laden trucks in the city, and all moving so noiselessly as to remind one of the rubber tired traffic on a park boulevard.

"In Jersey City, Hudson Street was paved with three-inch wood blocks three years ago. It is the heaviest traveled street in the city, all of the heavy trucking from the Pennsylvania Railroad ferry passing over it, and this traffic is continuous during the twenty-four hours of the day. The condition of the street, as I observed it, was perfect.

"On none of the streets of Jersey City paved with wood has there been anything spent for maintenance.

"In a personal interview with Mr. J. H. Sullivan, Superintendent of Streets of Boston, and one of the recognized paving experts of the country, he told me that the creosoted wood block streets of Boston had cost absolutely nothing for maintenance during the ten years and less that they have been in use."

Booklets illustrating Wood Block Pavements in various parts of the country and giving complete information will be sent free on request, to any address.

U. S. WOOD PRESERVING CO.

165 BROADWAY NEW YORK

PAV[illegible] PITCH

ELASTIC AND INDESTRUCTIBLE

BARRETT'S PAVING PITCH is elastic and pliable and readily conforms to the changes of surface caused by settling in the foundation or sand cushion. It adheres closely to the paving block, forming a perfect binder, yet its elasticity prevents any breakage of bond at the joints by passage of heavy trucks and wagons.

Barrett's Paving Pitch is practically indestructible. It is a long-lived filler that makes a well-preserved and lasting pavement. Contrast with this a rigid cement which allows for no settling and soon breaks up under ordinary traffic, or a sand filler which does not bind at all, but leaves each paving block independent of the others and unsupported.

Many asphalt fillers also lack in binding qualities and tensile strength; they seem "dead" and tend to disintegrate shortly after application. An asphalt filler is also most difficult of application, especially in brick pavements in which the interstices are very small. It chills quickly and will not pass down readily to the base of the blocks.

Barrett's Paving Pitch by its elasticity allows for expansion and contraction of the blocks without the necessity of special expansion joints.

With Paving Pitch "every joint is an expansion joint."

The price of Barrett's Paving Pitch is low. It requires no special skill for application.

BOOKLET GIVING FURTHER INFORMATION ON REQUEST

Barrett Manufacturing Company

New York	Chicago	Philadelphia	Boston
Cincinnati	Cleveland	Pittsburg	Minneapolis
Kansas City	New Orleans	St. Louis Seattle	London, Eng.

ASPHALT

THE GENUINE

CUBAN NATURAL ASPHALT

The Standard Material for

Cubanel

TRADE MARK

STREET PAVEMENTS and ROAD BUILDING
MALLEABLE PAVEMENTS that stand the wear
CEMENTITIOUS, HIGHLY DUCTILE Asphalt that holds the Macadam in place
For SHEET ASPHALT—ASPHALTIC CONCRETE and POURED MACADAM
Fillers for Brick, Granite and Wood Block Pavements
Specifications, Samples and Information sent upon request

INTERNATIONAL ASPHALT COMPANY

CHAMBER OF COMMERCE BLDG. - - - CHICAGO

C. T. WILLARD CO.

110 EAST 23d STREET, NEW YORK

Tel. 2727-2728 Gramercy

VITRIFIED MATERIAL OF ALL KINDS

VITRIFIED PAVING BLOCK
VITRIFIED PAVING BRICK
VITRIFIED BRICK FOR
SEWER INVERTS
LINING TUNNELS
PAVING FLOORS
PAVING MILL YARDS
SIDE-WALKS
VITRIFIED TILE
SALT GLAZED AND UNGLAZED
&c., &c.

Acid-Proof
Battery Room Floor Tile, Size 8 x 8 x 2

A Short List of Representative Places where Our Material is in use:

Erie R. R., Otisville Tunnel Lining.
Bush Docks, Brooklyn, N. Y., Paving.
Municipal Ferry, St. George, S. I., Plaza Floors.
N. Y. C. & H. R. R. R., Battery Room Floors.
Electric Storage Battery Co., Philadelphia, Pa., Battery Floors.
Brooklyn Edison Co., Battery Room Floors.
New York Public Library, 42d Street and Fifth Avenue, N. Y. City, Floor and Walks.
New York Post Office Roofs.
New York Custom House Roofs.
Hundreds of Streets, Gutters, Sewers, Sidewalks, Mill-floors and Yards, &c., &c., all over the country.

Small Size Vitrified Paver
We have all Sizes and Shapes

COCKBURN COMPANY

Works: 12th, 13th and MONMOUTH STREETS, JERSEY CITY, N. J.
Office: 126 LIBERTY STREET, NEW YORK

THE LOCKWOOD AUTOMATIC BUCKETS AND SKIPS

"Dumped by the man behind the engine"

FOR LARGE MASSES OF CONCRETE:

Works very quickly, the concrete being discharged the instant it is over the form, and the bucket swung back on the car, in less time than would be required to get a hand operated bucket in position to dump.

FOR CAISSONS OR BRIDGE CYLINDERS:

It places the concrete with no men below. There are no handles to catch, no catches to uncatch.

FOR NARROW FORMS:

Narrow forms can be filled by the Lockwood Bucket by letting out a thin steady stream. The bucket is always under control of the engineer, and there is no strain on the forms caused by the entire mass dropping in a lump.

THE COCKBURN GROUT MIXER AND EJECTOR

FOR STOPPING LEAKS IN TUNNELS AND DAMS, FOR RENEWING FOUNDATIONS:

This machine will mix six hundred bags of cement each eight hours into liquid grout and deliver it

WHERE, WHEN AND AS WANTED.

Write for special information.

Squeegee STREET WASHING MACHINE

Street cleaning costs in Washington, D. C., given in Annual Report, Commissioners, District of Columbia, 1911.

Squeegee
11.62 cents per 1,000 sq. yds.

Pressure Flushing Machine
31.57 cents per 1,000 sq. yds.

Machine Sweeping
22.75 cents per 1,000 sq. yds.

Hand Sweeping
17.52 cents per 1,000 sq. yds.

Most Effective, Economical, Sanitary Method of Street Cleaning. Removes Oil, Grease, Fine Dust, and All Heavy Street Dirt. Leaves Pavement Clean as a Kitchen Floor. Write for Catalogue giving full Description of Machine and Report of New York test.

KINDLING MACHINERY CO. 348-350 BROADWAY MILWAUKEE, WIS.

VULCAN LOCOMOTIVES

have been demonstrated to be the

BEST STEAMERS, BEST PULLERS and BEST CONSTRUCTION

For Contractors, Industrial, Switching and General Haulage, of any on the Market

Repair parts always on hand

VULCAN IRON WORKS

WILKES-BARRE, PA.

N. Y. Office - - 50 Church St.

FLORY HOISTING ENGINES

Steam and Electrical

FOR

CONTRACTORS, MINES, QUARRIES DREDGE AND CABLEWAYS

Are made on the duplicate part system

There are several hundred styles and sizes to select from for the different operating conditions.

On request catalogs, prices, etc., will be furnished.

S. FLORY MFG. CO. :: BANGOR, PA.

JOHN FOX NICHOLAS ENGEL

JOHN FOX & CO.

POSTAL TELEGRAPH BLDG.

253 BROADWAY, NEW YORK

TELEPHONE, 5747 BARCLAY

CAST-IRON GAS AND WATER PIPE

General Foundry and Machine Work

Flange Pipe and Specials, Sewer Castings, Fire Hydrants, Valves, Lamp Posts. : : : : : : :

Supplies of all kinds for Water and Gas Works, Railroads, Contractors, Engineers, etc., etc.

American Pipe & Construction Co.

112 N. Broad St., Philadelphia

ENGINEERS AND CONTRACTORS

Also Manufacturers of

WELDED WROUGHT IRON PIPE

lined and covered with pure cement—bell and spigot joints for lead caulking

The Only Non-Corrosive Pipe on the Market **Good for any Pressure**

ESTABLISHED 1844

A. SCHRADER'S SON, INC.,

28-30-32 Rose Street
NEW YORK CITY

Manufacturers of

DIVING

APPARATUS

We make divers' outfits of all kinds, and invite inquiries from wreckers, contractors, bridge companies, water works, or any one who contemplates the use of such an apparatus.

Furnisher of Diving Apparatus to U S. Navy and U. S. Army Engineers' Corps.

Awarded—Gold Medal at Jamestown Exposition, 1907; Grand Prize at the Alaska-Yukon-Pacific Exposition, 1909.

LAKEWOOD LINE

Lakewood Mixer, buckets, steel cars, turntables, transfers, portable track, dump cars, floor hoppers, hoists, chutes, hoist towers, bin gates, scaffold winches, concrete carts, spreader carts, etc. PROMPT SHIPMENT from New York City, Philadelphia, Cleveland or Chicago.

ROAD BUILDING

The Lakewood Mixer

Heating and Mixing Asphaltic Concrete, Asphalt Macadam, Tar Mixtures of Any Kind. **AND MIXING** Hydraulic Cement Concrete for sub-base **IN ONE MACHINE** represents: Speed, Economy, and Increased Profits.

The Portable RAPID Heated MIXER

Combines the functions of a non-clogging mixer and heating plant. Separate construction, but acts as a unit without danger of igniting asphalt.

NOT AN EXPERIMENT

We have a year's evidence of its making good to offer you.

COMPARE "RAPID MIXER" COSTS

with your "Old Method" figures.

LABOR COSTS FOR MIXING ASPHALTIC CONCRETE

1¼ inch Top, 3 to 4 Cents per Square Yard
2 inch Top, 4 to 5 Cents per Square Yard
3 inch Top, 5 to 7 Cents per Square Yard

This includes every man on the job.

You can have full details and any proof you want on request to

W. VAN R. WHITALL, INC.

NEW YORK
32 Church Street

PHILADELPHIA
Real Estate Trust Bldg.

Additional safety and economy in

Track Maintenance

has been proved by the use of Continuous Weber and Wolhaupter base-supported rail joints—after fifteen (15) years' service.

CONTINUOUS INSULATED JOINT

CONTINUOUS

ROLLED FROM BEST QUALITY STEEL

OVER 30,000 MILES IN USE

Highest Awards:
Paris, 1900
Buffalo, 1901
St. Louis, 1904

WEBER

WOLHAUPTER

Catalog at

AGENCIES:

Boston, Mass.
Chicago, Ill
Denver, Col
Pittsburg, Pa.
Portland, Oregon
St. Louis, Mo
Troy, N. Y.
London, E. C., Eng.
Montreal, Canada

CONTINUOUS GIRDER

WEBER INSULATED JOINT

THE RAIL JOINT COMPANY

Makers of Base Supported Rail Joints for Standard and Special Rail Sections, also Girder, Step or Compromise, Frog and Switch, and Insulated Rail Joints, Protected by Patents.

GENERAL OFFICES, 185 Madison Avenue, NEW YORK CITY

CLYDE Hoisting Engines

are high grade engines designed and built to

Show Best Results

in General Contracting, Bridge Building, Railroad Work, Pile Driving, Coal Yards, Docks, Dredging and Quarries. We Build them any size, any type and for all purposes.

THEIR STRONG POINTS ARE:

Best Materials	**Maximum Results**
Steel Gears and Ratchets	**General Durability**
Interchangeable Parts	**Guaranteed Efficiency**

Catalogue and Estimates sent on request

CLYDE IRON WORKS, DULUTH, MINN.

BRANCH OFFICES:

Chicago, Ill., 318-19 Fisher Building
New Orleans, La., 421 Carondelet Street
New York City, 30 Church Street
Savannah, Ga., Germania Bank Building
Houston, Texas, 1315 Carter Building

MUNICIPAL JOURNAL

50 Union Square (4th Ave. & 17th St.), New York

A. PRESCOTT FOLWELL, *Editor*

SCOPE—A reliable, conservative, independent and progressive weekly journal devoted exclusively to Municipal Improvements, Municipal News and Advance Contract News.

SUBJECTS—It treats exhaustively of Streets and Roads, Water Supply, Lighting, Sewerage, Sewage Disposal, Garbage Collection and Disposal, Municipal Finances, Franchises, and the Pros and Cons of Municipal Ownership.

CONTRACT NEWS COST DATA—It gathers and publishes Advance Contract News, and comparative data on cost of Municipal Utilities in different cities, together with figures on cost of operation and maintenance.

MUNICIPAL NEWS—It chronicles weekly the happenings and events of interest and importance in the various municipalities throughout the country and presents classified forecasts of municipal work in prospect.

INFORMATION BUREAU—It furnishes subscribers upon request with special information upon any municipal problem or cites them to sources where it may be obtained.

DIGEST OF CURRENT MUNICIPAL LITERATURE—It prints each month a complete list of articles upon municipal questions which appeared the preceding month in all periodicals of importance, and supplies these articles at cost.

LEGAL DECISIONS—Publishes digests of all Important legal decisions of the higher courts resulting from municipal litigation.

DISCUSSIONS—Encourages debate upon vital questions affecting municipal life and progress.

Subscription price $3.00 a year.

1840 72 YEARS 1912

The Evening Post Job Printing Office

JOHN NOLTY, President

OFFICE AND PLANT:

156 FULTON STREET, corner of BROADWAY, NEW YORK

Telephones: 1315-1316-1317 Cortlandt

Not connected with any newspaper

THIS OFFICE is continually receiving unsolicited testimonials from its patrons, showing great appreciation of the quality of the work it produces and of the invariable promptness for which the house is so celebrated.

EQUIPPED with the latest machinery and with the most skillful employees, it is in a position to produce printing of any description, whether of a TECHNICAL, LEGAL, or GENERAL nature.

THIS BOOK IS A SAMPLE OF OUR WORK

HARLEM CONTRACTING COMPANY

MANUFACTURERS *of*

ASPHALT BLOCKS

2 RECTOR STREET
NEW YORK

THE

Hastings Pavement Co.

25 BROAD STREET

NEW YORK

Asphalt Blocks

AND

TILES

Manufacturers—Contractors

MECHANICAL FILTRATION
FOR MUNICIPAL AND INDUSTRIAL USE
ALL SIZES, TO SUIT LOCATIONS

THE "HOLYOKE" FIRE HYDRANT
THE STANDARD OF NEW ENGLAND

OUR "IMPROVED WALKER" HYDRANT
WITH RUBBER-FACED GATE - - BRONZE MOUNTED
ADOPTED BY MANY CITIES

Write for Catalogues and Prices

Norwood Engineering Co. - - Florence, Mass.

NEW YORK STEAM CO.

FURNISHES STEAM FOR POWER AND
HEAT THROUGH STREET MAINS

140 CEDAR STREET WEST STREET BUILDING NEW YORK
UPTOWN OFFICE, NO. 624 MADISON AVENUE

BUYING ONE?
Your security is the reputation of the line.
LUFKIN
MEASURING TAPES
are tools maintaining a high reputation.
THE LUFKIN RULE CO. SAGINAW, MICH. New York
London, England
Windsor, Can.

J-M Asbestos and Magnesia Products

Asbestos Products of Every Description

J-M Asbestos Pipe and Boiler Coverings
J-M Sectional Underground Conduit
J-M Fibre Conduit
J-M Asbestos Roofing and Asbestoside
J-M Asbestos Packings (for all purposes)
J-M Success Liquid Chemical Fire Extinguisher
J-M Transite Asbestos Wood and Shingles
J-M Sound Deadening Felts
Keystone Hair Insulator
J-M Cold-Storage Insulation
J-M Sanitor Closet Seats and Tanks
J-M Vitribestos Stack Lining
J-M Asbestos Fire-Proof Cements
J-M Asbestos Fabrics
J-M Leak-No Metalic Compound
J-M Manville Dry Powder Fire Extinguisher
J-M Automobile Brake Lining
J-M Linolite System of Electric Lighting
J-M Electrical Supplies, etc.

Write for Catalogue

H. W. JOHNS-MANVILLE CO.

MADISON AVENUE and 41st STREET :: NEW YORK

Office and Warehouse in Every Large City

ROBERT A. KEASBEY CO.

100 North Moore Street

Tel. 6097 Franklin **NEW YORK CITY**

STEAM PIPE AND

BOILER COVERINGS

"RAKCO" BRAND

Asbestos **Flax** **Rubber**

PACKINGS

Ransome Mixers

ARE

Indispensable to the Municipal Contractor, and have proven their superiority over other makes on many Municipal and general Engineering works.

RANSOME MIXERS are pre-eminently time, labor and money savers.

The long engineering and contracting experience of this company has resulted in the collection of hundreds of successful schemes of mixing plant arrangements for street paving and other jobs. The contractor is welcome to the use of the same.

The Engineer-Contractor will find our co-operation of exceptional value in engineering and contracting works requiring machinery as of our superior manufacture.

RANSOME CONCRETE MACHINERY CO.

DUNELLEN, N. J.

W. E. AUSTIN MACHINERY CO., Southern Sales Mgrs., Atlanta, Ga.

New Orleans — Houston — Dallas
Oklahoma City — Roanoke — Norfolk

W. B. HOUGH CO., Monadnock Block, Chicago, Ill.

Minneapolis — Des Moines — Detroit — Indianapolis

The A. P. Smith Mfg. Co.

East Orange, N. J.

Make connections under pressure with **The Smith Tapping Machine.**

Makes connections in mains without shutting off water, regardless of size or location, just where you want them. No leakage, simply and easily operated strong and durable—not expensive either. *Send for bulletin.*

Use Service Tapping Machines for Inserting Corporation Cocks.

No device its equal for quick and economical work. Light enough to be carried and handled by one man, yet strong and durable. Sold at a fair price.

We will send this machine and samples of Standard Corporation Cocks on trial. *Write for further details.*

Pipe Cutting Machine. Operates in close quarters.

Needs but little room, can be used anywhere, cuts clean and true. Won't break or start the next joint. a labor and time saver all around.

We make patented tools and supplies for water works—all tried and proven money savers. *May we send you bulletins?*

No leaky joints when you use **O'Neil Patent Calking Machine.**

Calks joints perfectly in one-sixth the time required by hand. Fits pipe from 24 inches to 48 inches—gas or water

Sluice Gates and Hoisting Mechanism

FOR

WATER-WORKS HYDRO-ELECTRIC

AND

IRRITATION

SYSTEMS

Catalogue on Application

COLDWELL-WILCOX CO.

VERPLANCK AVE. NEWBURGH, N. Y.

THE SLOGAN OF THE CAMERON—"CHARACTER: THE GRANDEST THING"

A. S. CAMERON STEAM PUMP WORKS

NEW YORK, N. Y.

DESIGNERS AND BUILDERS OF SIMPLEX AND COMPOUND, PISTON AND PLUNGER PUMPS, HORIZONTAL AND VERTICAL; BOILER FEED, FIRE, OIL LINE, MINE, STATION AND SINKING, MARINE, PRESSURE, AIR AND VACUUM PUMPS; ALSO SUCTION AND JET CONDENSERS.

Cameron Pumps

are backed by more than half a century of valuable experience. They have gained a world-wide reputation for simplicity, durability, reliability and economy, as they give years of lasting satisfaction at the least cost. Investigate their record.

MEAD-MORRISON MANUFACTURING COMPANY

MEAD-MORRISON GRABS, both Clam Shell and Orange Peel Types, are correct in design, of robust construction, durable and efficient. They have renewable bronze bushings and renewable steel jaws.

FOR CONTRACTORS' WORK, whether it be Dock, Railroad, Bridge, or Building Construction, Pile Driving or running Trench Machines, the MEAD-MORRISON STANDARD HOISTING ENGINE is a superior machine. There are also Mead-Morrison Electric and Steam Hoisting Engines for every service.

NEW YORK, 149 Broadway

Works and General Office: CAMBRIDGE, MASS.

Engineers in Charge of Construction will Find our Catalogues very valuable Reference Works

FREE FOR THE ASKING

STANDARD SEWER PIPE
3" TO 36" INCLUSIVE

DOUBLE STRENGTH SEWER PIPE
15" TO 36" INCLUSIVE

WALL COPING

FLUE LININGS

BUILDING BRICK

PAVING BLOCKS
(SHALE OR FIRE CLAY)

HIGH-GRADE FIRE BRICK

PATTON CLAY MANUFACTURING CO.

PATTON, PA.

Will cheerfully furnish information on any of these lines

FRANK JACOBUS
PRESIDENT

LOUIS J. SCHUSSLER
TREASURER

CHARLES A. FOX
VICE-PRESIDENT AND
GENERAL MANAGER

PHOENIX SAND AND GRAVEL COMPANY

Specialties

WASHED
SCREENED
SAND AND
GRITS FOR
GENERAL
AND
CONCRETE
WORK

17 STATE STREET
NEW YORK

TELEPHONES 752 AND 753 BROAD

Specialties

WASHED
GRADED
GRAVEL FOR
CONCRETE
WORK
IN SIZES
FROM
¼" TO 2'

Clinton Point Stone Company

WHITEHALL BUILDING 17 BATTERY PLACE
ROOM No. 2628

Dealers in Crushed Stone

CAPACITY 5,000 CUBIC YARDS PER DAY

Telephone Rector 3733

THE STALEY POWER TAMPING MACHINE

A Thoroughly practical, and extremely simple power tamping machine. The standard machine will tamp from 1,200 to 1,500 square feet of surface per hour. On trench work the machine will tamp from forty to fifty lineal feet of trench 30 inches wide per hour. The machine will strike any square inch in a trench up to four feet wide, and at any level from one foot above the surface to six feet below. This machine will make from 50 to 60 blows per minute with a ninety pound tamper and a two foot stroke.

Machine is sold on a ten days trial with freight paid both ways if not satisfactory.

Manufactured by

R. H. STALEY, SPRINGFIELD, ILL.

MUNDY'S

HOISTING ENGINES

MINING AND MUD DREDGING ENGINES

ELECTRIC HOISTS

STEAM BOILERS

DERRICKS AND PILE DRIVERS

NONE BETTER

J. S. MUNDY'S ENGINE WORKS

NEWARK, N. J.

"YELLOW STRAND"
"POWERSTEEL" WIRE ROPE

¶ Many thousand feet of YELLOW STRAND Wire Rope are being used in the construction of the 55-story

WOOLWORTH BUILDING
NEW YORK CITY

¶ The Highest Efficiency Rope in the World for the Highest Building in the World.

¶ Simply another Yellow Strand Record.

¶ A Yellow Strand in Your Rope Means Yellow Gold in Your Pocket.

CATALOGUE M. E. is indispensable to prospective wire rope users. Those with experience always specify Yellow Strand

BRODERICK & BASCOM ROPE COMPANY

76 WARREN STREET, NEW YORK CITY

St. Louis, Mo. Seattle, Wash. San Francisco, Cal.

FACTORIES: St. Louis, Mo., Seattle, Wash.

MAPS. MAKING, MOUNTING, COLORING

Your attention is called to our facilities,

1st. For making Maps, Charts and Diagrams for all sorts of requirements—by Bankers, Lawyers, Owners, Promoters, etc., for Railroads, Mines, Real Estate, History, Geography, Missionary, Law Suits, etc.

2nd. Printing editions of above in black and in colors, or coloring by hand by a special process, on paper or cloth.

3rd. Mounting on muslin, maps, charts, posters, diagrams, blue prints, architectural plans, diplomas, in fact any and every kind of printed matter on paper that needs to be reinforced, strengthened, and made durable.

4th. Mounting similar matter as above to hang on the wall, in what we call "Full Mounted" or "Half Mounted" styles.

5th. Mounting Posters and Show cards on Stretchers (with muslin backing) in "Stretcher" or "Theatrical style".

6th. Mounting on heavy board (Pulp, Compo or Van Dyck) to be used as "stand ups" in windows, etc., etc., or to be framed and hung on walls.

7th. Binding maps, etc., etc., in Atlas or pocket map styles.

8th. Map coloring; a specialty with us. It is a preferable process to printing (being more economical) for *small editions* of maps, charts, diagrams, etc.

HOUSE ESTABLISHED 1828 **E. C. BRIDGMAN** 86 Warren Street, N. Y.

Of Course You Want to Know

What Other Engineers

are

Doing, Saying, Thinking

Developments of today are standard practice tomorrow
—and antiquated the day after.

Engineering Record

can keep you in touch with every live subject in the whole civil engineering field.

It is a real, practical, constant help to every subscriber.

Add the RECORD to your working equipment—read it every week.

Issued Every Saturday
$3.00 Per Year

Sample copy free on request

Trial Subscription
20 Weeks for $1.00

Engineering Record, 239 West 39th Street, New York, N. Y.

MUNICIPAL ENGINEERS

are invited to send for sample copies of the paper which published more matter on the construction of Water-works and Sewers, Roads and Streets than any other technical weekly. A descriptive list of the leading articles published in 1911 will also be supplied to inquirers. Address

Engineering & Contracting
608 S. Dearborn St.
Chicago

nsulated

cased

ns

WIRE R

FOR EV

PURP

John A. Roebling's Sons Co.

OF NEW YORK

117-121 LIBERTY STREET

WORKS: TRENTON, N. J.

The Most Valuable Municipal Improvements

from an Engineering standpoint, generally originate with men having a comprehensive knowledge of past and present practice.

The editorial pages of Engineering News constitute one of the most thorough and reliable sources of information available on important municipal improvements, made and contemplated. The two volumes published each year comprise the best that can be obtained in current Engineering literature touching municipal affairs. The same matter in book form would cost many times the price of subscription.

City officials also find our advertising columns of great benefit on account of its unequalled circulation among contractors and manufacturers of engineering supplies. Engineering News is, without question, the principal medium for advertising work of a public or private nature for which competitive bids are desired.

Sample copy sent anywhere on request.

Subscription Price - - - $5.00 a Year

Proposal Advertising - - $2.40 an Inch

ENGINEERING NEWS

505 PEARL STREET NEW YORK CITY

One

Visible Model 10

Remington

Typewriter

in use in your office, will absolutely prove to you the enduring leadership of the Remington. And every additional one simply piles up the proof.

Remember that we *guarantee* your satisfaction.

Remington Typewriter Company

(Incorporated)

New York and Everywhere

GEORGE M. EDDY & CO.

345 TO 353 CLASSON AVENUE

BROOKLYN, N. Y.

Pioneers of the Tape Manufacturing Business in America, and the only firm giving its whole time and entire attention to the manufacturing of Tape Measures.

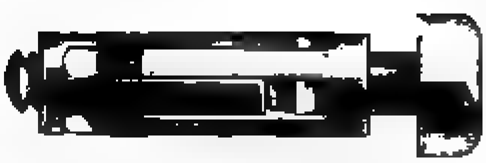
The Bolt That Can't Come Loose

Philadelphia Expansion Bolts expand **in the hole** as you tighten them.
The greater the tension the tighter they hold.

SEND FOR
CATALOG X

Steward & Romaine Mfg. Co.

128 North 6th St.
Philadelphia, Pa.

Evans' "Crescent"  Expansion Bolts

Patented March 14, 1905

Wherever anything is to be fastened to Stone, Brick, or Concrete, these bolts are the best.

Put fittings in hole; put on what you have to fasten; screw in the bolt. The fittings of soft steel have threads in lower end, but not in upper, and they draw together, expanding on *all sides* and *both ends.*

The bolts will never get loose. The greater the strain, the more they hold.

F. H. EVANS, 31 to 35 Hewes Street, BROOKLYN, N. Y.

812-814 GATES AVENUE, BROOKLYN, N. Y.

WHEN in the market for reliable and strictly first-class SURVEYING INSTRUMENTS consult **F. E. BRANDIS SONS & CO.**, who make but ONE QUALITY, and that is THE BEST. Their motto is, MECHANICAL PERFECTION, UNAPPROACHABLE ACCURACY. THEY ARE NOT IN THE MARKET with FINE, FINER and FINEST QUALITY, but with a just return for your investment. NO COMMERCIAL HARDWARE. Correspondence solicited.

Their large Illustrated Hand-Book and Catalogue mailed to any Civil Engineer and Surveyor.

BUFF

1.—The "BUFF" is the result of fifty years of instrument study by our Mr. Geo. L. Buff, our present manager.

2.—The "BUFF" has the least number of parts, which accounts for its accuracy; also the reason why it holds its adjustment better than any other instrument.

To prove the superiority of the "BUFF" we refer you to a few of our New York City users, shown below, who choose them for their accurate work.

Public Service Commission, (over 100),
Board of Water Supply,
Department of Public Works, (Manhattan, Richmond and Brooklyn),
Department of Parks, (Queens and Brooklyn),
Title Guarantee & Trust Co.
Hudson Tunnels, Penna., D. L. & W., New York Central, Erie, Interborough and Lehigh Valley Railroads,
Thompson-Starrett Foundation Co., Post & McCord.

Also many others too numerous to mention.

Please note we *repair* all makes of Instruments in a faithful manner, at lowest cost consistent with accurate work.

BUFF & BUFF MFG. CO.

80 CHURCH STREET **NEW YORK CITY**

TELEPHONE: SPRING 1006

HENRY V. ST. GEORGE, Inc.

MANUFACTURERS OF

ENGINEERING AND DRAFTING SPECIALTIES

10-12-14 GRAND STREET **NEW YORK**

TRACING CLOTH OUTLINED WITH TITLE AND OTHER DATA

BY HELIOGRAPHIC PROCESS, INSURING BEST RESULTS IN BLUEPRINTS.

MATERIAL LISTS, TIE LISTS, QUADRILLE RULING AND ALL KINDS OF DESIGNS.

MECHANICAL DEVICES FOR DEMONSTRATIVE ADVERTISING, CALCULATORS AND COMPUTORS, MAPS AND CHARTS TO ORDER.

I. C. C.
CENTRAL DIVISION
DATE NO.
SCALE

BAUSCH & LOMB OPTICAL CO.

ROCHESTER, N. Y.

Manufacturers of High Grade

Engineering Instruments

SPECIALIZING IN

Interior focus, dust and water proof telescope
Variable power eyepiece, illumination control
Tarnish proof graduations, red and black figures
3-screw base of American design
Saegmuller Solar, counterpoise plummet
Mining and slope stake attachments
Superior optics, permanent adjustments
Transits, Tachymeters, Theodolites
Levels and Alidades of superior construction
Correspondence solicited.

TELEGRAPH AND CABLE ADDRESS } YOUNGSONS — ESTABLISHED 1820

YOUNG & SONS

PHILADELPHIA

ENGINEERING, MINING AND SURVEYING INSTRUMENTS

TRANSITS AND LEVELS WITH NON-WORKING PARTS MADE OF AN ALUMINUM ALLOY, LIGHT AND RIGID

Patented "Ball Bearing" Transits and Levels

INVENTORS AND INTRODUCERS AMERICAN ENGINEERS' TRANSIT

BOOTH BROS. & HURRICANE ISLE GRANITE CO. OF NEW YORK

PRINCIPAL OFFICE: 206 BROADWAY, NEW YORK.

TELEPHONE, CORTLANDT 3110

Branch Offices,

NEW LONDON, CONN. ROCKLAND, ME.

QUARRIES:

CONNECTICUT WHITE, Waterford, Conn.
LONG COVE, Me.
ATLANTIC, St. George, Me.
STATE POINT, St. George, Me.
WALDOBORO, Lincoln Co., Me.
GRANITE ISLAND, Vinal Haven, Me.
PEQUOIT, Vinal Haven, Me.
JONESBORO RED, Jonesboro, Me.

HUDSON RIVER **GENUINE NORTH RIVER**

BLUE STONE

Curb, Flag, Crossing,
Sills, Lintels, Watertable, Steps,
Coping, Etc.

ANY DESIRED FINISH FOR STREET OR BUILDING WORK

50 CHURCH STREET, NEW YORK

'PHONE 1552 CORTLANDT **C. C. BULL, *Sales Agt.***

Rockport Granite Co.

PRODUCERS of

Granite for All Purposes

Room 2306

21 PARK ROW
NEW YORK CITY

Telephone
6032 Cortlandt

MAIN OFFICE: ROCKPORT, MASS.

F. E. FOSTER

REPRESENTATIVE, NEW YORK OFFICE

STANDARD

Macadam Asphalt Binder

Surface Treatment, Standard Macadam Asphalt Binder "A," Applied Hot, West Drive, Central Park, New York

Standard Macadam Asphalt Binders form a road that is waterproof, solid and durable; a road that keeps an even surface and remains free from dust.

Standard Macadam Asphalt Binder "A"

Between a heavy road oil and a solid binder. Specially suitable for roads that have been stripped of the original surface, and have the top course of stone exposed.

Standard Macadam Asphalt Binders "B" and "C"

Practically solid products, to be incorporated with the road material, either by the penetration or the mixing method. "C" is slightly harder than "B"; for use under warmer climatic conditions.

Asphalt Road Oil In four grades, containing from 30% to 60% asphaltum. For use on well made roads as they are. One application usually lasts a season.

Emulsifying Road Oil A lighter asphaltic oil, prepared to mix readily with water. Particularly serviceable as a dust preventive for parks, private estates, boulevards, etc. Requires frequent application where traffic is heavy.

Illustrated Booklet Free

We will mail you free, upon request, our Standard Road Oil Booklet, profusely illustrated. It explains the particular uses for which the different oils are prepared and how they should be applied to give the best results.

The information it contains will be found invaluable to Supervisors, Road Commissioners, State, County and Municipal authorities, and to owners of private estates.

Standard Oil Company of New York

Road Oil Department **26 Broadway, N. Y.**

RODGERS & HAGERTY, INC.

General Contractors

41 PARK ROW NEW YORK CITY

QUALITY

IN BIG THINGS QUALITY COUNTS

ENGINEERS are people who see things big, and see them far ahead. They realize that after construction endurance is the main thing, results and permanent results are what you want.

To have the weight of the highest building in the world, the Woolworth, resting on our cement means something. To have an increase of fourteen hundred per cent. in as many years, means something. It means that the infinite care we take in our mills has its reward.

Next time you have something big on hand, say like the Galveston Causeway, pick the brand that puts quality above everything else. Drop into our office and talk it over. You'll be welcomed by the

LEHIGH PORTLAND CEMENT COMPANY

261 Broadway, New York

CHICAGO, ILL. ALLENTOWN, PA.

"The Standard by which all other makes are measured"

"ATLAS" used exclusively on the Panama Canal and the great Keokuk Dam, the two largest concrete jobs in the country.

THE ATLAS PORTLAND CEMENT CO.

Philadelphia, Pa. 30 BROAD STREET, N. Y. Chicago, Ill.

Manufacturers also of Atlas-White Portland Cement

THE BARBER ASPHALT PAVING CO.

PHILADELPHIA, PA.

NEW YORK OFFICE: 30 CHURCH STREET

Largest Producers of Natural Asphalt and Asphaltic Products in the World

Bermudez Lake Asphalt
For roads and streets
Trinidad Lake Asphalt
For city pavements
Trinidad Liquid Asphalt
For road treatment
Asphalt Blocks
Creosoted Wood Blocks and general timber preservation

Genasco Ready Roofing
Built-up Roofs
Positive Seal asphaltic cement and fabrics for waterproofing
Mastic for floors, etc.
Building Papers
Gilsonite, etc., etc.

Offices in all principal cities. **Main refinery: MAURER, N. J.**

HOISTS

STEAM HOISTS
ELECTRIC HOISTS
BELT HOISTS

We build hoists for every kind of service. We have more than 300 regular catalogued styles and sizes. We build Steam Hoists up to 1,000 H. P.; Electric Hoists up to any size.

CABLEWAYS

The Panama Type High-Speed Cableway designed for building the Gatun Locks, gives double the speed and nearly double the capacity of any previous design.

DERRICKS AND DERRICK IRONS

LIDGERWOOD MFG. CO.

96 LIBERTY STREET *NEW YORK, N. Y.*

The CASE Line of Road Building Machinery

has demonstrated its superiority by its high record output its low cost of maintenance, durability and reliability

CASE STEAM ROAD ROLLER

The CASE is a practical roller that can be used for any kind of road construction work, either traction or stationary; and has more points of advantage than any other roller on the market. If you want the most substantial, the best constructed and the most efficient roller you should get a CASE.

CASE PERFECTION ROAD GRADERS

These graders embody in their construction every advantage of any other make and besides many features of excellence not possessed by others. They are strongly built, efficient machines that will give the maximum of satisfactory service over a period of many years.

OUR OTHER ROAD BUILDING MACHINERY

consists of the famous H. & L. Adjustable Road Drags; Railroad and Township Grading Plows; Road Rooters; Two-wheel, Fresno and Drag Road Scrapers; Rock Crushers, both portable and stationary; Stone Graders and Portable Bins; Dump Wagons and Dump Boxes; Sprinklers and Wheelbarrows.

FURTHER INFORMATION AND DESCRIPTIONS

If you want to know more about the most practical, reliable and efficient line of machinery for constructing and maintaining municipal highways, roads and streets, get our catalogue "N" on Road Machinery. This book is the most complete catalog on the subject and an authority on good roads building.

J. I. CASE THRESHING MACHINE CO., Inc.
RACINE, WISCONSIN, U. S. A.

OUR GUARANTEES *for the*

OTIS FEED WATER HEATER OIL SEPARATOR AND PURIFIER

FIRST—We guarantee that our Heaters can be more easily and thoroughly clean than any other Tubular Heater in the market, *and that they retain their heating qualities when other heaters have been useless.*

SECOND—To heat the feed water to the boiling point, 210 degrees to 212 degrees Fahr., with the exhaust steam without causing any back pressure when a heater containing 1 square foot of heating surface for each h. p. is used.

THIRD—That——. But send for our "Circular A," giving all 12 guarantees and telling why we make each one when you use an Otis Feed Water Heater, Oil Separator and Purifier. It is guaranteed to be in active service long after you have scrapped all others. Combines all the elements necessary to deliver the feed water to your boilers, free from oil, scale and grit, without back pressure. Longest lived and easiest cleaned on the market. Write us for reasons why.

STEWART HEATER CO.

349 NORFOLK STREET BUFFALO, N. Y.

WILLIAM FLINN
Chairman

GEO. H. FLINN
Sec'y & Treas.

BOOTH AND FLINN, LTD.

Contractors

General Offices
1942 FORBES STREET

PITTSBURG, PENN.

Recognition of Dunn Wire-Cut-Lug Brick

Important cities and towns throughout the entire United States have recognized the many advantages of Wire-Cut-Lug Brick, and over 400 have revised their specifications to admit of their use. Let us send you a list of these cities. New ones are being added daily.

Manufacturers of paving brick are fast beginning to anticipate the demand for the new brick.

Contractors who have laid **Dunn Wire-Cut-Lug Brick** prefer them to ordinary repressed brick, because they are easier to lay and make it more easily possible to carry out specifications.

The Reasons Why Wire-Cut-Lug Brick Excel all Others

BOND—The *uniform* lugs keep all brick an equal distance apart, admitting free flow of filler or bonding material. The rough, wire-cut surfaces, coming in contact with the filler, give many times greater bonding strength than is possible with the smooth surfaces of repressed brick.

SURFACE—The square edges make the smoothest pavement possible. Filler can be brought up even with the surface without danger of its being broken away as from the smooth rounded corners of repressed brick.

DURABILITY—Dunn's Wire-Cut-Lug Brick are greater density than ordinary pressed brick, and are, therefore, more durable. The repressing process always decreases the density of brick.

STRENGTH—Rattler tests show a smaller percentage of loss from Wire-Cut-Lug Brick than the same quality of repressed brick.

COST—Since the repressing process is eliminated in the manufacture of **Wire-Cut-Lug Brick**, the cost of manufacture, including the license fee, is not increased.

Let us suggest how to revise your Specifications to include them. Write us today.

THE DUNN WIRE-CUT-LUG BRICK CO.

CONNEAUT, OHIO

Patented in the United States, Canada and Mexico

Municipal Engineering and Contracting Equipment and Supplies

The Jeffrey Line includes Elevating, Conveying and Power Transmission Machinery for all purposes, Coal and Ashes Handling Equipments, Chains, Revolving Screens, Crushers, Shredders, Pulverizers, etc.

Write for Catalogs and familiarize yourself with this line.

JEFFREY MFG. CO. :-: COLUMBUS, OHIO

IROQUOIS IRON WORKS

BUFFALO, NEW YORK

NEW YORK OFFICE
30 CHURCH STREET

Manufacturers of a Complete Line of Paving and Road Making Tools and Machinery

TANDEM ROLLERS
MACADAM ROLLERS
SELF-PROPELLED ASPHALT-CONCRETE MIXERS
ASPHALT MIXERS (Small)
HEATING KETTLES (50, 100, 150, 400 Gals.)
FIRE WAGONS
SURFACE HEATERS
OLD MATERIAL PANS
TAMPERS, CUTTERS
HOES, RAKES
MELTING POTS
DIPPERS, SANDALS, Etc., Etc.

The Iroquois line is based upon 18 years' experience in the design and manufacture of trouble-proof, long-service tools and machinery of every description for street paving and road building.

Send for Catalogues.

KETTLES FOR HEATING ASPHALT AND TAR

This kettle is designed especially for road builders. Furnished in any size from 200 to 500 gals. Racks for carrying cord wood have been built on top, making it possible to keep material hot on long hauls. Boiler can be replaced without sending whole kettle to shop for repairs. Built in the most substantial manner.

We also manufacture the Mullen Heater for heating broken stone or gravel.

You should have our complete catalogue showing the best line of specialties and tools for paving and road building. A copy will be sent promptly on request.

HENRY J. McCOY COMPANY, 65-67 Dey Street, New York, N.Y.

VENTURI METERS

VENTURI METER TUBE

NEW YORK CITY has the 3 largest water meters in the world. They are set in the new Catskill Aqueduct and each one has a capacity of 650,000,000 gallons per day. An illustrated description of these meters will be mailed upon request.

BUILDERS IRON FOUNDRY :: Providence, R. I.

Telephone Connection — City Surveyor

WATSON G. CLARK

Civil Engineer

30 CHURCH STREET, NEW YORK

Bridges — *Sewerage* — *Water-Works*

DOCK CONSTRUCTION — TEST BORINGS FOR FOUNDATIONS

Municipal Engineers and Contractors

PROTECT your concrete pavement at the expansion joint by using our Armor Plates. We have 275,000 square yards of this pavement now in use, part of which has been down three years under heavy traffic.

There were 225,000 square yards constructed during the past year. The greater portion of this work was constructed in and around Detroit, in the vicinity where the first of these pavements was built. These armored joints are as good as the day the streets were opened for traffic. Can any other method show these results?

Our system of placing these plates by means of special sectional division plates insures a true and even joint, absolutely flush with the balance of pavement. No ruts or depressions at this point.

We are prepared to ship steel plates rolled into shape to fit standard curves of street pavements. Special curves rolled to order.

The following places are now using our Armor Plates for concrete pavement: Highland Park, Mich., Wayne County, under the direction of the Wayne County Road Commissioners; Walkerville, Ont.; Jackson, Mich.; Alpena, Mich.; Akron, Ohio; Detroit, Mich.; and Hamtramck, Mich.

Send for free booklet describing our methods.

THE R. D. BAKER CO. :: :: Detroit, Mich.

VACUUM CLEANING SYSTEMS

A SYSTEM WHICH DOES AWAY WITH DRY AND WET TANKS, SCREENS, STRAINERS AND OTHER SUCH CONTRIVANCES

Steam or Electric Driven
High—Low—Medium Vacuum
As may be desired

SUITABLE FOR RESIDENCES, APARTMENTS, HOTELS, OFFICE BUILDINGS, HOSPITALS, FACTORIES, SCHOOLS, ETC., ETC.

OUR SYSTEM IS ENDORSED by the leading Architects and Engineers.

OUR INSTALLATIONS INCLUDE many of the largest buildings in various Cities throughout the United States, including THE NEW NEW YORK POST OFFICE BUILDING now under construction.

Catalogues and Treatise on Vacuum Cleaning will be mailed promptly on request

AMERICAN ROTARY VALVE COMPANY

CHICAGO, ILL. — **156 N. Dearborn St.**

NEW YORK CITY — **220 Fifth Ave.**